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GRAPE CULTURE IN CALIFORNIA.

(ITS DIFFICULTIES; PHYLLOXERA AND RESISTANT VINES; OTHER VINE DISEASES.)

BY FREDERIC T. BIOLETTI.

IMPROVED METHODS OF WINE MAKING.

BY FREDERIC T. BIOLETTI.

YEASTS FROM CALIFORNIA GRAPES.

BY HANS C. HOLM.

Rupestris St. George.

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GRAPE CULTURE IN CALIFORNIA.

By F. T. BIOLETTI.

WORK OF THE STATION.

The growing of grapes and the industries based thereon are in a peculiar sense Californian. California produces, approximately, all the raisins, three quarters of the wine, and a large share of the shipping grapes of the United States.

All these industries have increased in importance with a steady and healthy growth during the last thirty or forty years, and during the last ten years the increase has been about 75%. The new plantations have been particularly numerous and extensive during the last five years. At present there are over 200,000 acres of vineyard in the State, and the prospects of continued expansion are favorable.

The growing of grapes has many practical and sentimental attractions both for capitalists and small farmers. No other branch of agriculture offers more certainty of steady, profitable returns for invested capital, and none offers superior inducements to the owner of a few acres of land in his effort to make a pleasant and adequate living by his own labor.

There is very little of the arable land of California which is not capable of producing abundant crops of good grapes, and the future output will be limited only by the demand and extent of the market.

The very attractiveness of viticulture and the peculiar suitability of California for its development involve dangers which must be avoided if we are to reap the best results from our advantages. A very large proportion of our new arrivals and settlers engage in some branch of grape-growing. Most of them have no knowledge of the business, or have preconceived ideas which are incompatible with our conditions. These conditions are so different from those of the Eastern States, and even from those of most of the grape-growing regions of Europe, that grape-growers from New York, Bordeaux, Burgundy or the Rhingau often fail to obtain better results than those who have had no previous practical experience in cultivating the vine.

In spite of California's superb advantages as a grape-growing region, statistics show that our average crop per acre is considerably less than that of Algeria or many parts of the south of France, and is hardly superior to that of Burgundy or the Rhingau. On the other hand, the crops on our best vineyards, vineyards which are handled properly, with due regard to our special conditions, are unexcelled anywhere in the world.

Two things, therefore, are urgently needed. First, the diffusion of special viticultural and enological knowledge, and second, the scientific and practical investigation of our peculiar problems. Since 1876 the Agricultural College at Berkeley has given more or less attention to the work of instruction and research in viticulture. At first Prof. E. W. Hilgard conducted this work almost single-handed, and, as in so many other departments of agriculture, laid the solid foundations which have contributed so much to the improvement of our cultural methods. From 1880 to 1894 the Viticultural Commission did much to instruct our grape-growers and wine-makers in the theory and practice of their arts.

Since 1894 the only institution in California—in fact, in the United States—which has given special attention to viticulture has been the Agricultural College and Experiment Station of the University of California. The work has been carried on somewhat spasmodically, owing to the lack of regular appropriations. At some sessions of the Legislature provision has been made for this purpose; at others it has been omitted.

This uncertainty of support makes much of the work which ought to be done impossible, and all of it more difficult. Experiments are commenced, observers are trained, but, before the most valuable results are obtained, the work has to cease for lack of funds. When a new appropriation is made, new observers have to be trained and much of the experiment work has to be recommenced. This results in loss of time and efficiency and a much smaller output of valuable information than would be possible if there could be more continuity in the work.

The Legislature of 1905 set aside $10,000 for the furtherance of viticultural research during the two years commencing July 1, 1905, and a considerable amount of progress has been made.

Besides the work of investigation carried out under the provisions of the bill passed by the last Legislature, the regular viticultural work of the University has been carried on. This work is, in the main part, educational. It consists of courses in grape-growing and wine-making to regular students, and short courses in the same subjects to special students. Short courses and viticultural institutes have also been given, so far as our time and resources have allowed, for the benefit of those actually employed in the industry.

The short courses at Berkeley to grape-growers and wine-makers actively engaged in the occupations have not been a success, owing to the small number who have been able to leave their work long enough to attend them. The special viticultural institutes, on the other hand, have met with a success that is very encouraging.

These institutes are given, so far as possible, in any viticultural center wherever a sufficient demand is manifested and the traveling expenses of speakers is borne by the Farmers' Institute appropriation. They last either one or two days, usually Saturday, or Friday and Saturday. They are not only confined strictly to viticulture, but attempt to treat only one particular part of this subject. The part chosen is, so far as practicable, one of actual interest at the season when the institute takes place.

The plan adopted is to accompany the lectures by practical demonstration in the vineyard. Two or three hours in the morning are usually all that are devoted to lectures. The afternoon is spent in the vineyards, where the ideas developed in the lectures are put into practice. An evening session is sometimes held to discuss the work of the day or to treat some subject unsuited to field demonstration.

An attempt is always made to adapt the instruction to the immediate needs of the locality and season, and to the time available. The principal topics which so far have been taken up at these viticultural institutes are the following:

1. Starting a new vineyard.
2. Pruning table grapes.
3. Pruning wine grapes.
4. Pruning raisin grapes.
5. Pruning young vines.
6. Oidium of the vine and methods of control.
7. The phylloxera of the vine.
8. Resistant vines.
9. Methods of grafting.
10. New varieties of grapes.
11. Fertilization of vineyards.

Another important phase of the viticultural activities of the University consists in an ever-increasing correspondence with grape-growers and wine-makers. Advice is given, suggestions made, and, where practicable, vineyards and cellars are visited on request.

Perhaps the most effective part of our work at present consists of spreading the knowledge, gained in the older districts by veteran growers, among new arrivals and in new districts. The repetition of costly mistakes is thus often prevented. More of this work should be done, but the small number of observers and experts prevents very great expansion at present. Instead of two or three trained viticulturists, the extent of California and the magnitude of its industries require a dozen. It is to be desired that an efficient expert, trained in the science and practice of grape-growing and wine-making, should be stationed in every large viticultural section, ready to advise all who apply. The expense would be compensated a hundredfold by preventing the frequent repetition of many costly mistakes. Easily avoidable loss of hundreds of thousands of dollars occur every year through ignorance of the best methods of pruning, grafting, sulfuring, fermenting, packing, and all the various operations of the vineyard and cellar. Men suitable for such work in California are difficult to find. It requires an amount of practical experience and technical training which few possess. These requirements must, moreover, be coupled with personal qualifications of industry and judgment that make their possessors too valuable in other pursuits to make it possible to retain them unless they can be assured continuous employment at good salaries.

Publications of the Viticultural Department.—In the period of three years from January 1, 1905, to December 31, 1907, ten bulletins and five circulars have been published by the Viticultural Department. These represent the principal portion of the work which has been so far completed as to be of immediate use to growers and wine-makers. Minor topics and incomplete investigations are discussed shortly in the present bulletin.

PHYLLOXERA.

This vine disease is well established now in nearly every large grape-growing section, except those of southern California. There are still large areas of vineyard, however, in the San Joaquin and Sacramento valleys which have thus far escaped the pest. The slowness with which it has spread in these regions is remarkable when we compare it with the rapidity with which vineyards were attacked and destroyed in Europe, and also in Sonoma, Napa, Santa Clara and other of the coast counties.

There are several obvious reasons which account in part for this slow extension. The various grape-growing districts are scattered throughout a wide plain, more or less isolated from each other by miles of grain or pasture lands.

Many of the vineyards are planted in sandy soil, where the progress of the pest is always slow. The natural power of resistance to this disease possessed by the Flame Tokay, though not sufficient alone to save it permanently, is no doubt a factor in saving vineyards of this variety from rapid destruction. There seems some reason to believe that this variety under special conditions, when growing in deep, rich soil, especially if somewhat sandy, might be kept sufficiently vigorous by careful cultivation and fertilization indefinitely. It would be unsafe to trust to this for immunity, however, unless the vineyard were situated where it could, if necessary, be given a winter submersion of three or four weeks every few years.

It is a mistake to suppose, however, that rich soil or ordinary irrigation give any practical degree of immunity. Vineyards in the richest and most copiously irrigated regions of the San Joaquin Valley have already been destroyed by the pest. What the effect of alkaline soil has in this respect is as yet undetermined.

When we have made every allowance for the known factors which operate to delay the spread of the Phylloxera in the great central valleys of California, they do not seem sufficient to completely account for its slowness. Even the fact that the vineyards and wine-growing regions are widely separated by fields where no vines grow is insufficient to account for the slow spread of the insect, when we know that the winged form may be transported by the wind 20 or 30 miles and still infect the vine on which it is deposited.

The most plausible theory seems to be that the winged form is absent or extremely rare in the interior of California. In fact, the winged form is produced most abundantly on American species of vines, growing in cool, moist situations, and especially when rains occur in June and July. As such conditions never occur in the interior valleys, it is not strange that the winged form should be rare. No record exists of winged individuals having been seen in California except in the coast valleys.

If this theory is correct, the only means the insect has of spreading from one vineyard to another in the great valleys is by crawling from vine to vine or by being carried on cuttings or roots. This makes the delay of the extension of the pest by proper quarantine measures particularly useful and effective.

These measures are of two kinds—those which can be carried out by each grape-grower himself, and those which require the enforcement of ordinances by quarantine officers. The first are as important and more generally practicable than the last.

If no winged insects occur there is no danger of introducing the pest on cuttings, for these never carry the root form. As their absence, however, is not proved anywhere, and as cuttings may come from regions where they do exist, it is the part of wisdom to disinfect all cuttings before planting.

Disinfection of Cuttings.—The easiest and most effective method for the use of the grape-grower is by means of bisulfid of carbon.

The method of using the bisulfid is as follows: Place the cuttings in a barrel or vat or a box made tight by means of a thick coat of paint or of paper pasted on the inside. On top of the cuttings place a saucer or other shallow dish, into which to pour the bisulfid of carbon. An ordinary saucer will hold enough for a box of 27 cubic feet or a 200-gallon vat. For larger receptacles it is better to use two or more saucers. Deeper vessels will not do, as the evaporation is not sufficiently rapid. After pouring the bisulfid into the saucer, cover the box with an oiled canvas sheet or other tight-fitting cover, and allow to stand for from forty-five to ninety minutes. At the end of this time there should be a little of the bisulfid left. If it has all evaporated this is proof that insufficient was used. No flame lights should be used, as the liquid burns easily and the fumes form an explosive mixture with the air. Lately, in Switzerland, a cellar was wrecked and a man killed by an explosion of vapors of bisulfid owing to a neglect of this precaution. Care should be taken not to spill any of the liquid on the cuttings, as it may kill them. It is advisable to cut off about half an inch of the lower end of the treated cuttings before planting, as the vapor injures the open pith.

Besides disinfecting the cuttings in this way, all the packing material in which they come should be burnt, or, if valuable, dipped in boiling water. Practically, it is impossible to disinfect rooted cuttings by this means satisfactorily on account of the difficulty of killing all the Phylloxera without seriously injuring the vine roots.

Disinfection of Roots.—For the disinfection of rooted vines dipping in hot water is recommended by the best European authorities. The roots should remain in water at 125°F. to 130°F. for ten minutes. The same treatment may be used for cuttings. The method has several inconveniences, however. Only small quantities can be disinfected at one time, and it requires great care to see that, on the one hand, the heating is sufficient to kill the insects, and, on the other, not sufficient to injure the vines. Experiments with this method by the University are not promising, and many of the rooted vines were killed.

It is probable that disinfection by means of hydrocyanic gas as practiced for nursery stock would be effective, but data is lacking on this point.

Delaying the Spread of Phylloxera.—When the Phylloxera has entered the vineyard it can not be found until it has increased sufficiently to kill or seriously weaken a vine. By this time it has usually spread to at least several neighboring vines. It is usually hopeless to attempt to eradicate it in this case without digging up and destroying a very large number of vines, and even in this case there is no assurance that other infected spots do not exist. Something, and in some cases, much, however, can be done to delay its spread, and the main part of a vineyard may often be preserved for many years by proper measures.

The first thing to be done when infection is first discovered is to dig up all the dead and weakened vines and a block surrounding them, including at least three rows of apparently healthy vines on all sides.

These vines should be all burned on the spot or piled up in the center of the infested block, sprayed with coal oil, and left for several months until the dry summer air has certainly killed all the insects on their roots. A more effective method is to treat the infested area with enough bisulfid of carbon to kill both the vines and the Phylloxera. This is done by making holes with a crowbar 12 inches deep every 18 inches over the whole area. Into each hole is poured 1½ ounces of bisulfid and the hole closed immediately with the foot. This treatment is best applied in April or May, after the vines have started and before the ground becomes too dry. If any vines survive this treatment, a new dose of 1 ounce to the 18 inches should be applied three weeks later.

However carefully either of these methods is carried out it affords only temporary relief. In Switzerland, Algeria, and Germany, where such methods have been applied with the utmost strictness and under military supervision, the spread of the pest has been checked but not stopped.

In any case, plows or cultivators should not pass through affected spots in the healthy parts of the vineyard. Cultivation is one of the most effective means of carrying the root insects from one part of the vineyard to another.

Every effort should be made to discourage the introduction of cuttings, and especially of roots, from infested to uninfested districts. Wherever possible it is best to obtain planting stock in the immediate neighborhood.

Reëstablishment of the Vineyard.—When a vineyard becomes thoroughly infested, that is, when it contains several scattered, diseased spots, or when 10% to 15% of the vines are known to be attacked, it is useless to attempt to delay the pest by these means. The only course to be followed in this case is to cultivate each block as long as it produces paying crops, and then to dig it up and replant it with bench grafted resistants. It is very bad policy to commence replanting single vines or small areas each year as they fail. A young resistant planted among old viniferas never gets the proper care, and has no chance to do its best. Where this method is adopted, the vineyard finally becomes a mixed lot of vines of various ages and of various degrees of unprofitableness. Replanting should be done in regular, rectangular blocks.

Planting New Vineyards.—In planting a vineyard in new soil, whether we should plant grafted resistants or viniferas on their own roots is to be determined by local conditions. If there is great likelihood of our vines being attacked before they have borne two or three crops it would be folly to plant anything but resistants. Hundreds of acres, in the aggregate, which have been planted in Phylloxera-infested districts have died before they ever produced a crop. On the other hand, if there is a fair chance of the vineyard remaining uninfested for many years it is often safe to plant non-resistants, and thus save the $30.00 to $40.00 per acre extra which a resistant vineyard will cost.

In the counties of Marin, Sonoma, Napa, Solano, Contra Costa, Alameda, Santa Clara, Santa Cruz, and San Mateo, where the Phylloxera is very generally distributed, it is throwing work away to plant anything but resistant vines. The same is true of those districts in the Sacramento and San Joaquin valleys where the pest has obtained a secure foothold. In any district it is unsafe to plant non-resistants anywhere within two or three miles of an infested vineyard.

RESISTANT VINES.

The demand for information regarding Phylloxera-resistant vines becomes every day more pressing. The problems of the adaptation of various stocks to various soils and climates, of the suitability of various combinations of stock and scion, and of the best methods of grafting have, therefore, been given as much attention as possible.

Rupestris St. George.—Probably nine tenths of the resistant vines being planted in California at the present time are Rupestris St. George. This is undoubtedly a most excellent stock for a large portion of the country. It is giving its best results in the interior valleys and in the warmer parts of the coast valleys and hillsides. Numerous cases of partial failure, however, have been noted, which make it certain that for many locations a better stock is to be found.

Most of the cases of failure have been reported from Sonoma, Napa, and Santa Clara counties. They can nearly all be traced to unsuitable soil conditions. Where there is an impermeable subsoil (bed rock or compact clay) the St. George usually fails. Under such conditions, if the soil is dry, the vines make poor growth; if wet, the roots decay and the vines die. A very compact clay soil, even when deep, seems unsuited to this variety, at least when grafted with certain varieties, such as Emperor and Cornichon.

In some cases the vines grow well, but the crops are unsatisfactory. This has been noted only in rich valley soil of the coast counties and only with certain varieties. A similar condition has often been noted in Europe, but it is usually easily overcome by longer pruning and diminishes with age.

A more serious defect has been found in some of the cooler districts. Many varieties when grafted on St. George ripen from one to two weeks later than when grafted on Riparia and some other stocks. This is due, probably, to the great vigor of the stock, which keeps the vine growing late. It is a serious defect wherever there is difficulty in obtaining the desired amount of sugar in the grapes and wherever late grapes are liable to injury from the autumn rains.

It seems inadvisable, therefore, to plant St. George in cool situations, on northerly slopes of the coast ranges, in localities close to the coast, or on shallow, wet, very rich or stiff clay soils in any locality, and to use it only on deep, permeable soils in the warmer districts and locations.

EXPERIMENTS WITH VARIOUS STOCKS.

Through the courtesy of Mr. J. K. Moffit we have been able to take some very interesting notes on resistant vines at an experiment plot in his vineyard at St. Helena, Napa County.

This plot was planted in 1900, under the direction of the Experiment Station, with the resistant stocks and bench grafts which served for the experiments detailed in Bulletin 127. Since that time it has been looked after by Mr. B. Bruck, the manager of the vineyard. The following is a summary of the notes taken in 1905.

Three rows of 25 vines each were planted with various varieties of bench grafts; in one row the stock being Rupestris St. George, in another Riparia Gloire, and in the third Riparia Grande Glabre. In most cases there were two vines of each variety on the same stock, in some cases three, and in some only one. The results are, therefore, not quite so convincing as if they had been made on a larger scale:

Bench Grafted Vines. Planted in 1900.

Notes taken in 1905.

Scion.	Stock.	Growth in May.	Crop.	Remarks.
Kleinberger	Rip. gloire	Heavy	Poor	Much broken by wind.
Kleinberger	St. George	Heavy	None	Nearly all canes blown off.
Sultana	Rip. gloire	Strong	Good	Berries very large.
Sultana	St. George	Strong	Fair	Berries smaller than on Rip.
Blue Portuguese	Rip. gloire	Fair	Good.	
Burger	Rip. gloire		Very large	23 pounds to one vine.
Pinot Chardon'y	Rip. gloire	Fair	Good.	
Pinot Chardon'y	St. George	Very strong	Fair.	
Semillon	Rip. gloire	Strong	Large.	
Palomino	St. George	Very strong	Large.	
Valdepeñas	Rip. gloire	Very strong	Very large	22 pounds to one vine.
Valdepeñas	St. George	Very strong	Poor.	
Gros Mansenc	Rip. gloire	Fair	Heavy.	
Gros Mansenc	Rip. gr. glabre	Strong	Fair.	
Folle blanche	Rip. gloire	Strong	Very large	25.5 pounds to one vine.
Fresa	Rip. gloire	Fair	Fair.	
Fresa	Rip. gr. glabre	Strong	Fair.	
Marsanne	Rip. gloire	Strong	Fair.	
Marsanne	Rip. gr. glabre	Strong	Large.	
Marsanne	St. George	Fair	Fair.	
Vernaccia	Rip. gloire	Strong	Large.	
Vernaccia	Rip. gr. glabre	Very strong	Fair.	
Vernaccia	St. George	Strong	Fair.	
Cornichon	Rip. gr. glabre	Fair	Fair.	
Cornichon	St. George	Very strong	Good.	
Aramon	Rip. gr. glabre	Strong	Good	22.5 pounds to one vine.
Mataro	Rip. gr. glabre	Weak	Good.	
Mourisco preto	Rip. gr. glabre	Very strong	Fair.	
Huasco	Rip. gr. glabre	Fair	Fair	Much coulure.
Sultanina	Rip. gr. glabre	Very strong	Poor.	
Verdot	Rip. gr. glabre	Very strong	Good.	
Barbera	St. George	Very strong	Large.	
Beba	St. George	Very strong	Good	Berries very small.
Mantuo	St. George	Very strong	Fair	Berries very small.
Franken Riesl.	St. George	Very strong	Small	Much coulure.
Alicante Bous.	St. George	Very strong	Very large.	
Perruno	St. George	Very strong	Large.	

In a general way, all the varieties on all stocks looked sufficiently vigorous, with the exception of the Mataro on Riparia Grande Glabre. The vines on St. George were nearly always more vigorous than those on Riparia. Of the two Riparias the Grande Glabre seemed a little the more vigorous. The relative standing of the three stocks with regard to vigor is indicated in the following summary:

Comparison of Vigor of Vine on Various Stocks.

Vigor.	Number of Varieties on—		
	Riparia Gloire.	Riparia Grande Glabre.	St. George.
Very strong	2	5	11
Strong	5	3	2
Fair	4	2	1
Weak	0	1	0

The only variety which looked very weak was the Mataro on Rip. Grande Glabre. This corresponds with European experience where it is recommended to graft this variety only on vinifera × American hybrids, such as Aramon × Rupestris No. 1 and Mourvèdre × Rupestris 1202. Where the growth is marked "fair" the slight lack of vigor could generally be ascribed in part to the heavy crop. Exceptions to this are the Cornichon and Huasco (Muscat of Alexandria), which not only lacked vigor but also crop on Riparia.

The bearing on the various stocks may be compared in the same way in the following summary:

Comparison of Crops on Various Stocks.

Crop.	Number of Varieties on—		
	Riparia Gloire.	Riparia Grande Glabre.	St. George.
Very large	4	0	1
Large	2	1	3
Good	3	3	2
Fair	2	6	5
Small	1	1	3

This is hardly a fair comparison, for the reason that in most cases the same variety was not grafted on all three stocks. In all cases, however, where the same variety was grafted on both Riparia and Rupestris St. George, with the exception of the Cornichon and Fresa, the vines on Riparia had larger crops. This is shown by the following comparison:

Comparison of Crops on Riparia and Rupestris.

Variety.	Crop of Vines on—	
	Riparia.	Rupestris St. George.
Kleinberger	Poor	None.
Sultana	Good	Fair.
Chardonay	Good	Fair.
Valdepeñas	Very large	Poor.
Gros Mansenc	Heavy	Fair.
Fresa	Fair	Fair.
Marsanne	Fair to large	Fair.
Vernaccia	Fair to large	Fair.
Cornichon	Fair	Good.

It should be noted that all varieties indiscriminately were pruned short. If those which need long pruning when ungrafted had been pruned long, the showing would undoubtedly have been more favorable to the St. George. It is a very valuable characteristic of the Riparia, however, that it enables us to obtain good crops with short pruning from varieties which on their own roots require long pruning. This is exemplified in table on page 124 by the fact that of eleven varieties which ordinarily require long pruning eight varieties bore good crops with short pruning when grafted on Riparia; of seven long-pruning varieties grafted on St. George, only one bore good crops when pruned short. This was especially noticeable with the Valdepeñas and Gros Mansenc, which bore very fine crops on Riparia Gloire and very little on St. George.

The only long-pruning variety which bore well on St. George was the Barbera. Of the short pruning varieties the following bore well on St. George: Palomino, Alicante Bouschet, Perruno, and Cornichon.

The quality of the grapes was in nearly all cases, where a comparison was possible, better on Riparia stock than on St. George. The grapes were larger and sweeter. The higher sugar content was, moreover, usually accompanied by higher acidity, showing that the grapes were better developed. The following table includes varieties which were bearing on both Riparia and St. George, and shows very clearly the superiority of the former stock in regard to the quality of the must:

Analysis of Grapes from Grafted Vines.

St. Helena Plot. October 6, 1905.

Scion.	Stock.	Sugar.	Acid.	Remarks.
Valdepeñas	Rip. gloire	27.5	.65	Very ripe, a few grapes shriveled.
Valdepeñas	St. George	23.5	.56	Crop very small.
Zinfandel	Rip. gloire	26.5	.92	
Zinfandel	St. George	24.0	.85	Many dried grapes.
Aramon	Rip. gr. glabre	18.2	.96	Grapes small for Aramon.
Mourisco preto	Rip. gr. glabre	23.0	.66	
Blue Portuguese	Rip. gloire	32.2	.53	Much overripe.
Mataro	Rip. gr. glabre	19.0	.75	
Gros Mansenc	Rip. gr. glabre	26.7	1.12	
Gros Mansenc	Rip. gloire	24.1	1.20	
Fresa	Rip. gr. glabre	24.0	.83	
Fresa	Rip. gloire	26.6	.92	
Alicante Bouschet	St. George	18.2	.86	
Barbera	St. George	26.1	.87	
Marsanne	Rip. gr. glabre	25.0	.67	
Marsanne	Rip. gloire	23.3	.50	
Marsanne	St. George	21.6	.62	
Chardonay	Rip. gloire	25.0	.60	
Chardonay	Rip. gr. glabre	22.8	.87	
Semillon	Rip. gloire	26.5	.68	
Huasco	Rip. gr. glabre	27.1	.64	
Palomino	St. George	26.5	.55	
Palomino	St. George	29.0	.45	
Kleinberger	Rip. gloire	22.6	1.12	
Perruno	St. George	23.4	.47	
Franken Riesling	St. George	26.5	.59	
Sultana	St. George	24.7	.75	
Sultana	Rip. gloire	24.0	.75	
Mantuo	St. George	27.1	.39	Many small grapes.
Beba	Rip. gr. glabre	20.3	.41	Grapes very small.
Cornichon	Rip. gr. glabre	20.3	.77	
Cornichon	St. George	18.4	.65	Grapes very fine.

Comparison of Composition of Grapes on Riparia and St. George.

Variety.	Stock.					
	Riparia Gloire.		Riparia Grande Glabre.		St. George.	
	Sugar.	*Acid.*	*Sugar.*	*Acid.*	*Sugar.*	*Acid.*
Valdepeñas	27.5	.65			23.5	.56
Zinfandel	26.5	.92			24.0	.85
Gros Mansenc	24.1	1.20	26.7	1.12		
Fresa	25.6	.92	24.0	.83		
Vernaccia	27.5	.84	27.6	.92	24.2	.61
Marsanne	23.3	.50	25.0	.67	21.6	.62
Chardonay	25.0	.60	22.8	.87		
Sultana	24.0	.75			24.7	.75
Cornichon			20.3	.77	18.4	.65
Mean	25.4	.80	24.4	.86	22.7	.67

These observations warn us that we should not hastily reject the Riparia as a stock. While there have been many failures on Riparia, these failures can be traced to lack of selection of the proper kind of Riparia and to the planting of Riparia on unsuitable soil. If we plant Riparia Gloire on rich, deep, loose, moist but well-drained soil, especially in the cooler districts, and avoid overbearing by too long pruning, we will probably obtain better results than by planting Rupestris St. George under the same conditions.

Zinfandel.—A very interesting part of the plot is a series of rows of different stocks field-grafted in 1900 with Zinfandel. Each row consisted of about 20 vines. A summary of the notes taken is given in the following table:

Notes on Zinfandel Grafted on Various Stocks.

Vines 5 years from grafting. 1905. St. Helena.

Stock.	Growth.			Crop.	Remarks.
	May.	Aug.	Sept.		
Rupestris Martin	Vigorous	Good		Large.	
101^{14}	Vigorous	Fair	Strong	Good	Looked a little weak in August, but recovered.
Rupestris St. George	Vigorous	Good		Good	Sugar 24.0, acid .85, many dried grapes.
3309	Good	Fair	Strong	Heavy	
101^{14}	Vigorous	Fair	Strong	Heavy	More vigorous than 3309, less than St. George.
Viala	Uneven	Weak	Fair	Fair	Vines all weakly.
Riparia Gloire	Strong		Fair	Good	Sugar 26.5, acid .92.
Solonis	Weak	Fair	Fair	Large	Growth uneven.
Rupestris Mission	Fair	Fair	Fair	Good.	
Munson	Strong		Good	Good.	
Riparia Grande Glabre			Fair	Fair.	

It is encouraging to find that our principal wine grape has given good results on all the principal stocks. The vigor and bearing of the vines on Riparia × Rupestris 3309 and 101^{14} were particularly fine.

Mondeuse.—One of the rows of this variety is grafted on Riparia Grande Glabre and is very vigorous and bearing good crops. About 600 vines of the same variety are grafted on St. George and are even more vigorous, but the crop is uneven. Owing to the vigor of the growth many canes were broken by the wind in the spring, which probably accounts for the variations in bearing. All the vines show a considerable amount of coulure.

Semillon grafted on St. George made good growth, but the crop was unsatisfactory and much coulured.

Ferrara on St. George (about 75 vines) showed excellent growth, but only a medium crop and much coulure.

Tokay on St. George (50 vines) was excellent. The vines were extremely vigorous and the crop good. The bunches were not compact, but were well filled. The tendency of the stock to produce coulure in this case had resulted simply in a thinning of the berries, which was an advantage.

St. Macaire on St. George has done very well, being vigorous, and producing good crops with short pruning.

Bench Grafts and Field Grafts.—In starting this experiment plot some of the rows were planted with bench grafts and the others with rooted resistants, which were field-grafted the following year. This gives us a good comparison of the two methods as regards the securing of a good stand.

Comparison of Bench Grafting and Field Grafting.

Stocks.	No. Growing 5th Year.	No. Failed by 5th Year.
FIELD GRAFTING (Zinfandel)—		
Rupestris St. George	39 = 68%	18 = 32%
Riparia × Rupestris 3309	36 = 72%	13 = 28%
Riparia × Rupestris 101[14]	42 = 84%	8 = 16%
Rupestris Martin	26 = 55%	21 = 45%
Vialla	16 = 70%	7 = 30%
Total	159 = 70%	67 = 30%
BENCH GRAFTING—	No. Growing 6th Year.	No. Failed by 6th Year.
Mondeuse on St. George	600 = 98%	14 = 3%
Tokay on St. George	48 = 96%	2 = 4%
Ferrara on St. George	70 = 93%	5 = 7%
Total	718 = 97%	21 = 3%

As all these vines were growing close together on the same kind of soil, and under the same management, the comparison speaks eloquently in favor of bench grafts as a means of obtaining a perfect "stand."

EXPERIENCE OF GROWERS. WINE GRAPES.

An attempt has been made to collect the experience with various resistant vines of growers in various sections. The experience of the older vineyards is of little use, and, in fact, apt to be misleading, as they were nearly all grafted on unselected Riparia and Rupestris. The stocks in the newer resistant vineyards are nearly all Rupestris St. George and Lenoir, so that the data for comparison are meagre. Some of the reports received, however, are interesting and are given here.

NAPA COUNTY.

B. Bruck, St. Helena.

	Vigor.	Crop.
Zinfandel on St. George, 7 years old, red, clay, hill soil	Good	Fair
Zinfandel on Lenoir, 8 years old, red, clay, hill soil	Good	Fair
Burger on St. George, 9 years old, rich, dry soil	Good	Large
Palomino on Lenoir, 9 years old, rich loam	Good	Good
Carignane on Lenoir, 8 years old, rich loam	Fine	Fine
Sauvignon vert on Riparia, 14 years old, rich loam	Fine	Fine
Sauvignon vert on St. George, 5 years old, rich loam	Fine	Fair
Johannisberger on Riparia, 10-14 years old, loamy soil	Fine	Fair
Johannisberger on St. George, 6 years old	Strong	Poor
Tokay on St. George, 7 years old, heavy soil	Good	Fair
Tokay on Lenoir, 8 years old, gravelly soil	Fair	Fair
Muscat on Lenoir, 8 years old, dry, gravelly	Weak	Good

The vineyard to which these notes refer is the same as that in which the experiment plot, reported on above, is situated. The results corroborate those of the plot. The crops of varieties grafted on St. George vary from poor to fair, with the exception of the Burger, whose natural tendency to heavy bearing has here been retained when grafted on St. George.

J. H. Wheeler, St. Helena.

Zinfandel on St. George, 1-8 years old	Vigorous and satisfactory.
Zinfandel on Lenoir, 1-18 years old	Vigorous and satisfactory.
Zinfandel on Riparia	Poor, gradually dying.
Burger on Lenoir, 1-12 years old	Very vigorous, good crops.
Muscat on Lenoir, 10 years old	Fair.

Mr. Wheeler states that all varieties grafted on Lenoir yield about one half the crop which they formerly did when growing on their own roots, but that the crops are regular. The same varieties grafted on St. George yield from one half to two thirds the crops formerly obtained before the advent of Phylloxera. This report is sufficient to condemn both stocks for this vineyard, as the experience in Europe is that whenever a stock suitable to the variety of scion and the nature of climate and soil is used, the crop of grafted vines is always larger than that of vines on their own roots. There can be little doubt that the Riparia × Rupestris hybrids would give better results in this vineyard.

Mr. Wheeler states further that Lenoir gives late ripening and low sugar with all varieties, that the same varieties on St. George ripen about two weeks earlier and attain from 1% to 3% more sugar. These varieties on Riparia ripen still earlier (1 to 2 weeks) and attain 1% to 2% more sugar than on St. George. This corroborates the experience on the St. Helena plot.

Crabb's Black Burgundy (Refosco) and Petite Sirah are said to fail occasionally on St. George, but a second graft on the same stock usually takes. This simply indicates a slight difficulty in grafting, and not necessarily any lack of affinity.

Fred S. Ewer, Rutherford.

Mr. Ewer finds the Lenoir a very satisfactory stock, as is shown by the following extract from a letter which he kindly wrote:

I would like to say, on the start, that my knowledge of the different resistant stocks (except Lenoir) is so limited that I shall not attempt to say much about any other than the Lenoir.

I have tried only three different resistants in all, Riparia, Rupestris St. George, and Lenoir, and all grafting on same was field work, as I have never been a believer in bench work for our place, believing we could get a vineyard quicker with the field grafting, and the little bench grafting I have done has proved it to my entire satisfaction.

The Riparia was a total failure with us at Rutherford, and a partial success at our small vineyard at St. Helena. We planted 3,000 Rupestris in vineyard, and grafted them at one year old, and only got a stand of 30%, where with the Lenoir we nearly always got from 90% to 95% of a stand, so you can easily see why I favor the Lenoir.

Under certain conditions, such as soil, climate, moisture, etc., I am inclined to think, from the experience of others, that the Rupestris is better than the Lenoir, but not for our place.

My preference for the Lenoir, summed up briefly, is as follows, viz.: Vigorous growers, ease of taking the graft, fine union, and few, if any, suckers, if properly prepared before planting.

I will say that as regards the bearing of the different varieties on resistant stock, I believe we get a better crop and more sugar now than we used to on the vinifera; that is to say, on all varieties we have, such as Chas. Font, Golden Chasselas, Semillon, Sauvignon vert, Traminer, Burger of the white varieties, and Crabb's Black Burgundy, Alicante Bouschet, Petite Sirah, Beclan, and a few Zinfandel of the reds.

I have Petite Sirah grafted on Lenoir fourteen years old, and growing strong and vigorous, and bearing good crops every year. I wish you could see the crop of grapes on them now; it looks like eight tons to the acre.

I believe I am the only person in this county who has grafted any Muscat on Lenoir, and my foreman said the other day there were more grapes on the vines than leaves, showing that the Muscat will do well on Lenoir; they are now eight years old and doing well.

It should be noted that the soil of Mr. Ewer's vineyard is very deep, rich, and liable to become very wet in the winter. These conditions are very favorable to the growth of new roots, and, to some extent, unfavorable to the Phylloxera. This is shown by the fact that some Zinfandel vines, on their own roots, are still bearing good crops, though they have been infested with Phylloxera for ten years or more. Under such conditions, the low resistance of the Lenoir is sufficient. It would be unsafe to conclude from this that Lenoir would be sufficiently resistant in other soils and under other conditions.

The failure of Riparia, noted both by Mr. Ewer and by Mr. Wheeler, is in part due no doubt to the use of unselected stock. If Riparia Gloire had been used it is probable that very different results would have been obtained.

G. de Latour, Rutherford.

	Vigor.	Crop.
Zinfandel on St. George, 5 years old, gravelly soil	Not good	3 tons
Burger on St. George, 5 years old, gravelly soil	Very good	6 tons
Alicante Bouschet on St. George, 5 years old, gravelly soil	Good	4 tons
Palomino on St. George, 5 years old, gravelly soil	Very good	2 tons
Sauvignon vert on St. George, 5 years old, gravelly soil	Very good	2 tons
Green Hungarian on St. George, 5 years old, gravelly soil	Very good	5 tons
Petite Sirah on St. George, gravelly soil	Weak	Good
Grand Noir on St. George, 3 years old, gravelly soil	Good	1½ tons

Mr. de Latour states further "* * * it seems that Zinfandel does not succeed very well on St. George; the union with Petite Sirah seems defective also. The Riparia × Rupestris 3309 seems to be still better than the Rupestris St. George."

SONOMA COUNTY.

L. Justi, Glen Ellen.

Reports that all the varieties of wine grapes in his district have grown vigorously and borne good crops on Lenoir, with the exception of the Petite Sirah, which sometimes fails. Alicante Bouschet and Burger do particularly well.

K. Nagasawa, Santa Rosa.

Zinfandel on St. George, 5 years old, on light ashy soil, becoming very hard in summer, are very vigorous and yield very well. Alicante Bouschet, Beclan and Muscadelle du Bordelais on the same stock are doing well, though too young to bear yet.

SAN JOAQUIN COUNTY.

F. and F. A. Arnold, Stockton.

Nature of soil: 24 acres—3 parts adobe and 1 part river sand and slickens; 3 to 6 feet deep; no overflow for years; no irrigation. Plowed 12 inches deep before planting cuttings; field grafting. Burger and Mission doing well on Rupestris St. George, Riparia Gloire, Riparia Grande Glabre, and Riparia × Rupestris hybrids.

SANTA CLARA COUNTY.

Paul Masson, San José.

Zinfandel on Rupestris St. George, 6 years old, satisfactory, good unions, healthy looking, but do not bear abundantly.

Burger on Rupestris St. George, 4 to 7 years old, field grafted; bad. Poor success from beginning, many dying every year, apparently from poor unions and lack of affinity. Same results on sandy, deep, rich gravelly and rich loamy soils.

Carignane and Pinot, 11 years old, planted on special soil, are doing well.

"I have quite a few acres of 11-year-old vines grafted on Rupestris St. George, including the following varieties: Carignane Mondeuse, Alicante Bouschet, Aramon, Grand Noir, Durif, Grenache, Pinot, Semillon, Sauvignon vert, Folle blanche, Colombar, Pinot blanc. These are all doing very well, and, if anything, more vigorous and prolific than ungrafted vines of the same age. Carignane and Grenache, 12 years old on St. George, have never failed to give a large crop, and Aramon also seems very prolific."

Mataro (grafted) is not very satisfactory; it bears heavily, but many die during the hot summer.

Thos. Casalegno, Evergreen.

Zinfandel on St. George, vigorous; coulures.

Mondeuse on Riparia, fair vigor and crop.

St. Macaire on Riparia, 9 years old, rocky soil, light growth, fair crop.

Carignane on Riparia, 10 years old, good growth and crop.

Carignane on St. George, 10 years old, clay soil, good growth and crop.

Carignane on St. George, 10 years old, gravel soil, good growth, but coulures.

Mataro on St. George, 7 years old, coulures.

Mataro on Riparia, good growth and crop.

Alicante Bouschet on St. George, 5 years old, strong growth, coulures.

Palomino on St. George, 7 years old, clay loam, good growth and crop.

Chasselas on St. George, 7 years old, clay loam, good growth and crop.

ALAMEDA COUNTY.

Grau & Werner, Irvington.

Tannat on Lenoir, 13 years old, healthy growth, but very light crop.

SANTA CRUZ COUNTY.

E. E. Meyer, Wrights.

Valdepeñas, 7 years old, and Green Hungarian, 6 years old, grafted on St. George, are growing vigorously, but the crops are not altogether satisfactory.

Summary of Reports from Growers.

Variety.	Vigor.			Crop.		
Zinfandel on St. George	Good 5		Poor 1	Good 1	Fair 4	
Zinfandel on Riparia			Poor 1			
Zinfandel on Lenoir	Good 2				Fair 2	
Carignane on St. George	Good 3			Good 2	Fair 1	
Carignane on Riparia	Good 2			Good 2		
Carignane on Lenoir	Good 1			Good 1		
Alicante Bouschet on St. George	Good 3			Good 1	Fair 1	
Alicante Bouschet on Lenoir	Good 1			Good 1		
Petite Sirah on St. George	Good 1		Poor 1	Good 2		
Petite Sirah on Lenoir	Good 1		Poor 2	Good 1	Fair 1	
Mondeuse on St. George	Good 1			Good 1		
Mondeuse on Riparia		Fair 1			Fair 1	
St. Macaire on St. George	Good 1			Good 1		
St. Macaire on Riparia		Fair 1			Fair 1	
Valdepeñas on St. George	Good 1				Fair 1	
Durif on St. George	Good 1			Good 1		
Mataro on St. George			Poor 1	Good 1	Fair 1	
Mataro on Riparia	Good 1			Good 1		
Burger on St. George	Good 2		Poor 1	Good 2		
Burger on Lenoir	Good 2			Good 2		
Palomino on St. George	Good 2			Good 2		Poor 1
Palomino on Lenoir	Good 2			Good 2		
Johannisberg Riesl. on St. George	Good 1					Poor 1
Johannisberg Riesl. on Riparia	Good 1				Fair 1	
Semillon on St. George	Good 1			Good 1		
Semillon on Lenoir	Good 1			Good 1		
Colombar on St. George	Good 3			Good 1	Fair 1	Poor 1
Colombar on Riparia	Good 1			Good 1		
Colombar on Lenoir	Good 1			Good 1		
Green Hungarian on St. George	Good 1				Fair 1	
Grenache on St. George	Good 2			Good 1		

STOCKS FOR THE FRESNO REGION.

In 1903 five plots of resistant vines were planted in the neighborhood of Fresno on land kindly placed at our disposal for that purpose by various growers.

The great importance of the raisin and wine industries in the upper San Joaquin Valley, and the special climatic and soil conditions of that region, make it very necessary that we should, as soon as possible, obtain some reliable information regarding stocks that will succeed there. European experience can be relied on less in this region than in the coast valleys. No part of France resembles the San Joaquin Valley, and in the parts of Spain which show the most nearly similar conditions the problems of resistant stocks are hardly more advanced than in California.

The five plots were planted primarily to determine the vigor of the most promising stocks in the region, and to provide cuttings for distribution to enable growers to make tests on their own places.

The following varieties, which include nearly all those which have given the best results in Europe, were planted:

Pure American Varieties.

1. Riparia Gloire de Montpellier.
2. Riparia Grande Glabre.
3. Rupestris Martin.
4. Rupestris St. George.
5. Berlandieri Rességuier No. 1.

Americo-American Varieties.

6. Riparia × Rupestris 3306.
7. Riparia × Rupestris 3309.
8. Riparia × Rupestris 101^{14}.
9. Riparia × Berlandieri 33E.
10. Riparia × Berlandieri 34E.
11. Riparia × Berlandieri 157^{11}.
12. Riparia × Berlandieri 420A.
13. Rupestris × Berlandieri 219A.
14. Rupestris × Berlandieri 301.
15. Solonis × Riparia 1615.
16. Solonis × Riparia 1616.
17. Riparia × Cordifolia-Rupestris 106^{8}.
18. Solonis × Cordifolia-Rupestris 202^{4}.

Franco-American Varieties.

19. Mataro × Rupestris 1202.
20. Aramon × Rupestris No. 1.

As might have been expected, nearly all of these varieties which started grew vigorously in the rich soil of the region. Cuttings were used in making the plantations, and the plots show strikingly the differences in facility of rooting of the different stocks. The Berlandieri and Berlandieri crosses rooted badly. The best of the latter in this respect was the Riparia × Berlandieri 157^{11}.

The four most vigorous of the stocks were 1616, 1202, 3306 and St. George. All of these in all the plots grew with extraordinary vigor and rapidity.

Seven other varieties grew with scarcely less vigor. These were 3309, 101^{14}, 1615, Riparia Gloire, 157^{11}, Aramon × Rupestris No. 1, and 106^{8}. Four varieties, 33E, 34E, 202^{4}, and Rupestris Martin grew with fair vigor, but were distinctly inferior to the above.

The only varieties of the list which made poor growth were Riparia Grande Glabre, 219A and 301.

Stocks for Muscat.—The importance of the Muscat of Alexandria, as the basis of our raisin vineyards, makes it highly important that a suitable stock for this variety should be found as soon as possible.

The invasion of the raisin vineyards of Spain by Phylloxera is comparatively recent, and little information is obtainable regarding the use of resistant stock there. In a general way it is stated that the usual resistant stocks are being used in the principal raisin-growing regions of the Peninsula with success. The Muscat of Alexandria is being grown to a limited extent as a table grape in southern France, and is said to succeed on any vigorous stock.

On the other hand, in South Africa, Muscat vineyards grafted on Rupestris St. George, Riparia Gloire, Aramon × Rupestris No. 1, and Rupestris Metallica have almost uniformly failed. After bearing several good crops the vines have generally died. No satisfactory explanation of this difference has been advanced. The most plausible seems to be that the vines have been killed by overbearing. The vines, in fact, have borne large crops before dying, and the only stock on which they have remained healthy is Lenoir, which has a tendency to induce light bearing with most varieties.

The grafting of Muscats on resistant stocks has been little practiced in California, but a few growers have vines which have been bearing several years on various stocks.

One grower reports that Muscats on Lenoir, 10 years old, have given fair results; another that they are weak, but bear well. One grower in Tulare County has dug up his Muscat vineyard grafted on Lenoir because so many of the vines had died. Two growers report that they have Muscats grafted on St. George which have been bearing well and growing vigorously for from 3 to 6 years. Another grower reports that his Muscats grafted on St. George and on Riparia Gloire have given three good crops and are equally vigorous. These results are on the whole encouraging.

While the question of the selection of the best stock is not so pressing in the case of raisin grapes as in that of wine grapes, because the greater part of the raisin district is still uninfested by Phylloxera, it will sooner or later be of vital importance to the industry. For this reason a number of test plots have been started, with the coöperation of growers in various sections where raisins are produced.

In 1904 Muscat cuttings were bench grafted on the following resistant stocks:

Rupestris St. George.
Riparia Gloire de Montpellier.
Riparia × Rupestris 3309, 3306, 101^{14}.
Solonis × Riparia 1616.
Riparia × Berlandieri 33E, 34E, 157^{11}.
Rupestris × Berlandieri 301A.
Solonis × Cordifolia-Rupestris 202^{4}.
Aramon × Rupestris No. 1.
Mourvèdre × Rupestris 1202.
Lenoir.

Several hundred rooted bench grafts on St. George and 1202 were obtained and distributed to a number of growers in various districts, principally in Fresno County. Smaller quantities on the other stocks were obtained and distributed to a more limited number of growers.

Notes taken on the quality of the bench grafts before they were distributed were as follows:

Muscat on St. George. Heavy growth, complete unions but large swellings.
Muscat on 101^{4}. Good growth, complete unions, large swellings.
Muscat on 3306. Small growth, complete unions, small swellings.
Muscat on 1202. Heavy growth, complete unions, large swellings.
Muscat on Lenoir. Good growth, complete unions, small swellings.

Reports have been received from most of the growers who received vines, but they are of little value yet as showing relative vigor of the various stocks. One of the most complete reports is given below, by Dr. W. N. Sherman, Fresno:

Muscat on St. George. All grew vigorously.
Muscat on Riparia Gloire. All grew vigorously.
Muscat on 101^{14}. Four out of six lived and made fair growth.
Muscat on 3306. Six out of ten lived and grew vigorously.
Muscat on 3309. All lived and grew vigorously.
Muscat on 1616. Six out of seven lived and grew vigorously.
Muscat on 33E. All lived, but made poor growth.
Muscat on 202^{4}. Four out of six lived and made fair growth.
Muscat on 1202. All lived and made vigorous growth.
Muscat on Lenoir. Nine out of ten lived and made fair growth.

These vines were planted in overwet soil, and were all more or less injured by early autumn frost. Too much emphasis should not, therefore, be placed on the fact that some of them died.

The other reports show in general that the Muscats on St. George 3306 and Riparia Gloire on the whole made the best growth, while 101^{14} and 33E generally made poor growth. The other stocks gave intermediate results. The results the first year are, however, apt to be misleading, even as regards vigor, for some stocks, for example, Berlandieri and its hybrids, are slow starting, but make a vigorous growth later. The question of crop can be determined of course only after several years of trial.

GENERAL RECOMMENDATION.

Only the pressing necessity of some rules to guide us in our immediate plantations will excuse the making of recommendations as to stocks in the present incomplete state of our knowledge of the behavior of the various stocks in the diverse conditions of our grape-growing regions. The present tendency to plant St. George in all soils and in all localities, however, is undoubtedly wrong, and has led to disappointment in many cases, and we already possess sufficient data to enable us to choose something better for many locations.

The Rupestris St. George has given its best results in the hot, dry interior on deep soils. It seems to be a particularly good stock for Tokay and Alicante Bouschet under such conditions. Its great vigor seems to promise a diminution of the tendency of the Tokay to sunburn, and the coulure which it produces with many varieties only extends to the production of loose bunches with the Tokay. This looseness of bunch is a distinct advantage with this variety. The coloring and ripening of the Tokay leave nothing to be desired when grafted on St. George.

For a great majority of our soils and varieties the two Riparia × Rupestris hybrids 3306 and 3309 promise to be superior in every way to the St. George. The former for the moister soils and the latter for the drier. The vigor and bearing of all varieties tested on these two stocks has so far been excellent, and they should in most cases replace St. George in all but the hottest and driest deep soils.

For the wettest locations in which vines are planted—in places where the water stands for many weeks during the winter, or where the bottom water rises too near the surface during the summer—the most promising stock is Solonis × Riparia 1616.

For moist, rich, deep, well-drained soils, especially in the coast counties and on northerly slopes, the St. George is utterly unsuited. The crops on this stock, in such locations, are apt to be small, and the sugar contents of the grapes defective. In these locations the Riparia Gloire is much to be preferred, and will undoubtedly give larger crops of better ripened grapes.

None of the above stocks give good results, as a rule, in very compact soils. For such soils the most promising varieties are 106^8 in the drier, and Aramon × Rupestris No. 1 or 202^4 in the wetter locations. In dry, shallow soils 420A and 157^{11} give promise of being excellent stocks.

This covers most of the soil conditions which occur in California. The only other cases which demand consideration are the varieties with defective affinity. For these varieties the most promising stock is 1202. This stock makes excellent unions with many varieties which fail on most resistants, and is to be tentatively recommended for Emperor, Ferrara, Cornichon, Muscat, Mataro, Folle blanche, Pinot, Gamay, Gutedel and any varieties which have not given generally satisfactory results on Riparia and Rupestris.

These recommendations may be summarized as follows:

For average, good soils in most locations—	
1. Drier soils	3309
2. Moister soils	3306
For special soils—	
3. Dry, deep, in hot regions and locations	St. George
4. Dry, deep, in cooler regions and locations	Rup. Martin
5. Dry, shallow	420A or 157^{11}
6. Dry and very compact	106^8
7. Wet and very compact	Aramon × Rup. No. 1 or 202^4
8. Wet, loose	1616
9. Rich, moist, deep, well drained in the cooler localities	Rip. Gloire
For varieties of defective affinity in good soils	1202

DESCRIPTION OF THE PRINCIPAL RESISTANT STOCKS.

In order to enable the grower to determine the correctness of the labeling of his resistant vines, the following brief description, adapted for the most part from "Les Vignes Americaines" of Prof. L. Ravax and accompanied by reproductions of original photographs, will be of assistance:

FIG. 1. Riparia Gloire de Montpellier. One third natural size.

Riparia Gloire de Montpellier (Fig. 1).—The most vigorous of all varieties of Riparia. Leaves *very large, as wide as long;* young leaves and tips pale green, canes and trunk thick. Male vine.

Roots well and grafts easily, either as cuttings or in the field. Trunk grows almost as large as the scion. Vines on this stock bear well, and the grapes are large, sweet and early.

Riparia Grande Glabre (Fig. 2).—Very vigorous, but does not grow so stout as the Riparia Gloire. Leaves large, longer than wide, with an

FIG. 2. Riparia Grande Glabre. One half natural size.

almost *rectangular outline,* due to the short *terminal lobe* and the *straight sides.* Roots thin, hard and wiry. Fertile vine.

Roots well, but does not take the graft so well as Riparia Gloire. Almost equal to Riparia Gloire, but subject to "folletage." *Folletage,* or sudden dying of the vine, is a common fault of the unselected Riparias formerly grown in California, and for this and other reasons

FIG. 3. Rupestris Martin. One half natural size.

the Riparia Gloire is to be preferred to the present or other varieties of this species.

Rupestris Martin (Fig. 3).—Very vigorous and one of the most robust of the existing stocks. Leaves larger than those of Rupestris St. George, and with a V-shaped petiolar sinus. Canes glabrous, pinkish, long and thick.

Roots easily, but is more difficult to graft than St. George. The grafts which grow are very satisfactory and are less liable to coulure than grafts on St. George. It succeeds in drier situations than the latter. Male vine.

Rupestris St. George (Fig. 4).—Perhaps the most vigorous of all the stocks grown when planted in suitable locations. Leaves small; the petiolar sinus very open, with a {-shaped outline. Canes and trunk very thick and robust.

This variety roots and grafts with great facility, and grows at least as large as any scion which is grafted on it. Succeeds in any soil except those underlaid with an impermeable or stiff clay subsoil.

FIG. 4. Rupestris St. George. One half natural size.

FIG. 4½. Rupestris Metallica of South Africa.

Rupestris Metallica (Fig. 4½).—The best varieties of Riparia and Rupestris give excellent results when they grow under appropriate soil and climatic conditions. Their range of adaptation, however, is comparatively small—that is, they are likely to give unsatisfactory results when planted in locations which differ in any considerable degree from those which suit them best. This seems to be due in great part to the direction their roots naturally take. Roots of Riparia are for the most part spreading and superficial, and succeed only where sufficient moisture exists near the surface. Roots of Rupestris are, on the contrary, plunging and deeply penetrating, and fail if an impenetrable subsoil prevents their taking their natural position.

FIG. 5. Riparia × Rupestris 3309. One half natural size.

Experience has shown that crosses between Riparia and Rupestris have a much wider range of adaptation than either of their parents, owing to the fact that they are capable of forming a strong root system in both the upper and lower layers of the soil. Moreover, the best of them retain all the good qualities of both parents—high resistance to Phylloxera, ease of rooting and grafting, vigor and fruitfulness of grafts. The best of these hybrids, according to European experience, are those known by the numbers 3309, 3306 and 101^{14}. The first two are the most promising in California.

Riparia × Rupestris 3309 (Fig. 5).—This variety resembles in habit a Rupestris, and the leaves are intermediate between those of the two parents.

It has small leaves, which, on the laterals, are rounded and without lobes. The young shoots and leaves are sparingly pubescent, but the rest of the vine is *glabrous,* and by this character readily distinguished from 3306. The vine is male, and therefore does not produce fruit.

Fig. 6. Riparia × Rupestris 3306. One half natural size.

Riparia × Rupestris 3306 (Fig. 6).—The general habit of this variety resembles also that of a Rupestris, but it is easily distinguished from 3309 by its *strongly pubescent* leaves and canes. Male vine.

Riparia × Rupestris 101^{14} (Fig. 7).—This variety resembles in habit its Riparia parent more than 3309 or 3306. Its range of adaptation is less than that of the latter, and it is most suited to fairly rich soils, such as those suitable to Riparia. It bears small bunches of small, round, black grapes.

Berlandieri Rességuier No. 1 (Fig. 8).—The pure Berlandieri varieties have all the qualities required in a stock—resistance to Phylloxera, ease of grafting, permanency of union, fertility of the scion, adaptation to varied soils—except one, that of ease of rooting. From 100 cuttings only 10 to 15 rooted vines are obtained by the usual methods of propagation. For this reason this species has never been used to any great extent. Certain crosses of this species with Riparia, however, while retaining the merits of the Berlandieri, possess rooting qualities almost equal to Riparia. They are particularly promising for shallow, stiff soils where the Riparia × Rupestris hybrids might suffer.

Riparia × Berlandieri 157[11] (Fig. 9).—This variety was obtained by crossing a Berlandieri with pollen from Riparia Gloire de Montpellier. It has the habit and leaves of a Berlandieri, and a root system intermediate between those of its parents. It is thoroughly resistant to Phylloxera, and its grafts are vigorous, fruitful, ripen well, and are not subject to coulure. The cuttings root fairly well, and field grafts succeed very well. It produces an abundance of strong canes, but

FIG. 7. Riparia × Rupestris 101[14]. One half natural size.

these do not ripen well in the cooler localities. It produces medium-sized bunches of round, black, pulpy grapes.

Riparia × Berlandieri 420A (Fig. 10).—This variety is perhaps superior to 157[11]. The cuttings root more easily, graft as well, and mature more regularly. It is more suited to bench grafting than the former, and makes vigorous and fruitful grafted vines. Male vine.

The Solonis is a hybrid of unknown parentage which resembles in its habits a Riparia. It was at one time much used as a stock, but its resistance to Phylloxera is insufficient. In California vines grafted on Solonis have been so weakened by Phylloxera as to be useless. Its only use is for wet, sandy soils, where it gives good results.

The good qualities of Solonis are found in certain of its crosses with Riparia, of which the most promising for California is 1616.

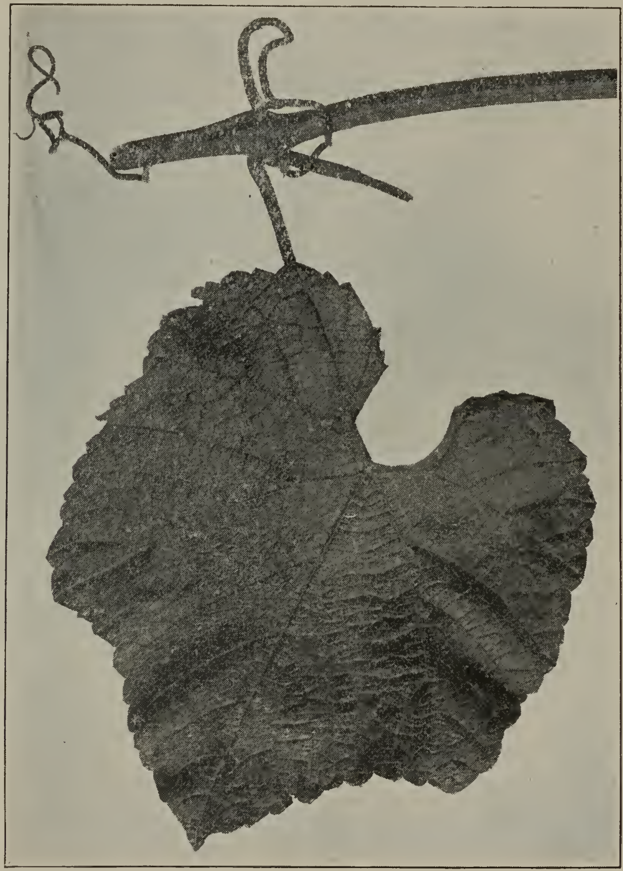

FIG. 8. Berlandieri Rességuier No. 1. One half natural size.

Solonis × Riparia 1616 (Fig. 11).—This variety is very vigorous, and the cuttings root and graft well. It is sufficiently resistant to Phylloxera, and is to be recommended for sandy and especially wet soils. Vine fertile, producing small, round, black grapes.

Riparia × Rupestris-Cordifolia 106^{8} (Fig. 12).—This variety is vigorous and thoroughly resistant to Phylloxera. It is particularly recommended for stiff clay soils which become hard after rain and easily dry out. It is in just such soils that Rupestris St. George and

Riparia have often failed in California, and this variety therefore promises to be useful. Vines produce small, round, black grapes.

Solonis × Cordifolia-Rupestris 202[4] (Fig. 12½).—This variety is adapted to soils similar to those suited to 106^8, but resists humidity

Fig. 9. Riparia × Berlandieri 157^{11}. One half natural size.

better. Prosper Gervais in his report to the Congrès International de Viticulture of 1900, at Paris, says: "The varieties 202^4 and 106^8 are especially suited to non-calcareous clay soils; the latter succeed in dry, poor, hot soils, providing they are not too shallow; the former in soils which are both compact and wet."

Aramon × Rupestris No. 1 (Fig. 13).—This variety is the result of a cross between the vinifera variety Aramon and Rupestris Ganzin.

FIG. 10. Riparia × Berlandieri 420A. One half natural size.

The leaves resemble Rupestris, and unlike most crosses containing vinifera, its resistance to Phylloxera is quite sufficient and superior to that of Lenoir. It is very vigorous and roots easily from cuttings. It is somewhat difficult to graft, but when successful the grafts make good unions and are vigorous and fruitful. Its chief merit is that it succeeds in wet, compact soils, where most other varieties fail.

Mourvèdre × Rupestris 1202 (Fig. 14).—This variety is a cross between the Mourvèdre (Mataro) and a Rupestris. It is, perhaps, the most widely planted of all the American vinifera hybrids. Prosper Gervais describes it as "A stock characterized by its extreme vigor, rapid development, ease of rooting and grafting, and the fruitfulness of its grafts." It is particularly suited to deep, rich, humid, clay soils, and makes excellent unions with all varieties of vinifera.

FIG. 11. Solonis × Riparia 1616. One half natural size.

The vine is fruitful, bearing large numbers of small, round, bluish-black grapes. It is grown extensively in France, Spain, Sicily, Portugal, and Roumania, and has given good results wherever tried. In California its vigor is remarkable, exceeding even that of Rupestris St. George.

OTHER VINE DISEASES.

Oidium.—The cause and treatment of this disease have been discussed in Bulletin 186, and the recommendations in it have been

FIG. 12. Riparia × Rupestris-Cordifolia 106[8]. One half natural size.

followed by a large number of growers this year in all parts of the State, usually with success.

All of the reported failures which have been investigated have been due either to the incomplete carrying out of the recommendations, or to the fact that the vines were suffering from some other cause which had been mistaken for *Oidium*.

Fig. 12½. Solonis × Cordifolia-Rupestris 202⁴.

The most common mistake of those who have attempted to follow the directions of the bulletin has been a failure to treat the vines thoroughly or rapidly enough in the beginning of the season. It can not be too strongly urged that the most effective way to control the mildew is by a thorough and effective sulfuring in the beginning of the season. This alone will in most parts of the State keep the vines free, and the sulfuring during the blossoming is needed only for its effect on the setting of the fruit, and as an extra precaution. Sulfuring later, if needed, is a proof that the first two have not been well done. This is true for the whole of the two central valleys and for most of California, except the coast belt subject to summer ocean fog.

Fig. 13. Aramon × Rupestris No. 1. One half natural size.

Definition of a Thorough and Effective First Sulfuring.—The first sulfuring should be made when the shoots are between 6 and 15 inches long. It should be done in such a way that *every part of every leaf of every vine in all parts of the vineyard* receives some sulfur, and the whole vineyard should be gone over in as short a time as possible. This will be a *thorough sulfuring.* To be *effective,* it must be followed immediately by two or three days of warm weather. Unless this happens, the sulfuring should be repeated as many times as are necessary until the proper weather conditions are obtained.

FIG 14. Mourvèdre × Rupestris 1202. One half natural size.

Mysterious Dying of Vines (*"Anaheim Disease"*).—The vine, like most plants, especially fruit trees, which are cultivated on a large scale, is subject to diseases of more or less intensity whose cause is not thoroughly understood. These diseases are (1) caused by parasitic organisms which have so far escaped detection, or (2) what is usually known as "physiological."

Physiological diseases are presumably due to some unfavorable conditions. For example, chlorosis, or the failure of the leaves to develop chlorophyll properly, is due to an excess of soluble lime carbonate in the soil, and is intensified by cold, dampness and the susceptibility of the variety.

The most serious of these two classes of diseases, which affects the vines, is the *Anaheim,* or, as it is sometimes called, the *California Vine Disease.* Notwithstanding that it has been the subject of continuous investigation for over fifteen years its cause is still quite obscure. Even the characterization and detection of the disease are so uncertain that vineyards, which after several years of observation by the most experienced investigators have been pronounced infected, have later been declared free. This has led to such a diversity of opinion that while one expert claims that the disease exists in every vineyard in the State, another would have us believe that no such disease exists at all, and that all cases of dying vines can be ascribed to one or other of the recognized vine diseases.

Neither of these extreme views seem to explain completely the observed facts. While many cases of supposed *Anaheim* have proved to be nothing but Phylloxera, root-rot, vine-hopper, drought, etc., there still remain a large number of unexplained cases.

In some cases the symptoms are practically identical with those of some of the "physiological" diseases which affect vine diseases in Europe. Typical cases of Rougeot have been noted in Contra Costa County, of *Brunissure* in San Joaquin, and of *Folletage* in Fresno, Kings, and other counties. In Sonoma County the disease of *Red-leaf,* which has some analogy with *Anaheim,* has been studied by Mr. O. Butler. An account of these diseases may be found in Bulletin 168, entitled "Observations on Some Vine Diseases in Sonoma County."

In a general way, as these troubles are due to soil and climatic conditions which weaken the vine, they are to be combated by cultural methods which tend to invigorate. Shorter pruning, thorough cultivation, irrigation or drainage, and fertilization will in most cases be effective in curing vines which are not too far gone.

Many cases have been brought to the attention of the station during the last two years, in which vines which were apparently healthy the previous year have failed to bud out in the spring, or budded out weakly and very late. The cause, in most cases, seemed to be some injury to the vines during the growing season of the previous year. This cause was in many cases the attacks of vine-hoppers. Black Prince vines growing in Tokay vineyards have very often been killed. This seems to be because the vine-hoppers, having a special fondness for this variety, congregate in large numbers on such isolated vines. Whenever the hoppers are sufficiently abundant to cause the dropping of the leaves in summer, the vine fails to ripen its wood properly.

Without mature green leaves the buds and canes do not receive the stores of starch which they need for the new growth in spring, and will either grow poorly the following year or fail to start at all.

When a new growth of leaves in autumn follows summer defoliation

FIG. 15. Brunissure on Tokay leaves.

by hoppers, mildew, or other causes, the effect is even worse. The new shoots which start exhaust what food reserves the vine possesses, and the leaves are killed by the early winter frosts before they have been able to return the supplies they have taken from the canes. Similar, but less severe, effects have been observed following a bad attack of *Oidium*.

This starvation of the canes and buds may be brought about in another way, namely, by the production of too large a crop. It is often possible, by excessively long pruning, to cause a vine to produce an abnormally large crop of grapes. The larger the crop the more material it takes from the vine, and if too large, the vine is unable to support it and at the same time lay up reserve materials in its canes and buds. In consequence, an extra large crop is often followed by weak growth in the spring, and a consequent small crop the following autumn. Vines of heavy bearing varieties may even be killed in this way, by repeated long pruning.

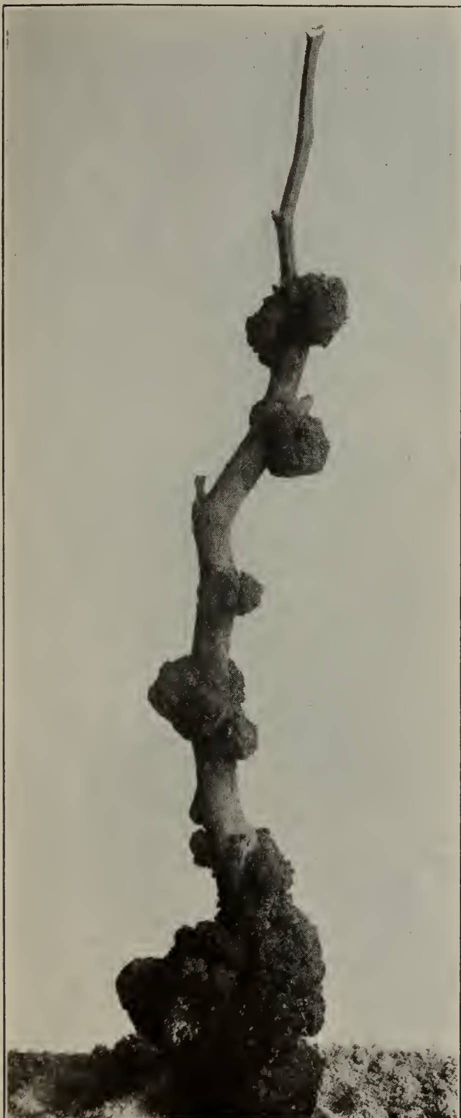

FIG. 16. Black Knot on 2-year-old Zinfandel.

This fact has been long recognized by practical grape-growers. Lately, Professor L. Ravaz,[1] of the National School of Agriculture at Montpellier, France, has advanced the opinion that the death of vines, as a consequence of overbearing, is much commoner than is usually supposed. This overbearing may occur as a consequence of various conditions other than long pruning. Some seasons are peculiarly favorable to heavy crops. Certain diseases and injuries induce temporary heavy bearing. Whatever the cause of abnormally heavy crops, Professor Ravaz believes that they may result in the death of vines. This is the explanation he gives of the death of large numbers of vines in southern France, Algeria, and other countries, and he ascribes our so-called *Anaheim* disease to the same cause.

[1] "Influence de la Surproduction sur la Vegetation de la Vigne," by L. Ravaz, Coulet et fils, Montpellier, 1906.

This is substantially the explanation given of the dying of vines in Santa Clara, in Bulletin 134, which was published before the region was declared infested by *Anaheim* disease. Whether this explanation is sufficient is still doubtful, though it is rendered probable by the fact that healthy young vineyards are now growing in Santa Clara, on the same soil where vines have been killed by "*Anaheim* disease."

FIG. 17. Black Knot on arm of old vine.

Black Knot.—This is one of the commonest and most widely distributed diseases of the vine in California. Many specimens are received by the Experiment Station every year, from nearly all vine-growing sections. It consists of peculiar growths, or swellings, usually near the surface of the ground on the upper parts of the roots or the lower part of the trunk. It often occurs, also, on all parts of the trunk and branches, but only rarely on the canes.

As a rule it does little damage unless it occurs on young vines, or attacks old vines very severely. Figure 16 is the photograph of a young vine very badly attacked, showing a large mass of knots at the surface of the ground, and four on the stem above the surface. Such a vine is almost girdled and could never develop into a healthy plant. Figure 17 shows the appearance of the knot on a branch or arm. In this case the knots could be removed and the vine might recover perfectly.

FIG. 18. Coulured bunch of Muscat of Alexandria.

It is not uncommon to find vines with large masses of knots on all sides of the trunk and on all the arms, which yet make a vigorous growth and produce good crops. When the knots extend all around the trunk of an old vine, however, it may be girdled, and, while it seldom dies, it may become weak and worthless.

Various theories have been advanced as to the cause of this disease, but the most commonly accepted is that it is due to abrupt changes of temperature, and especially to autumn frost occurring before the vine has become thoroughly dormant. This cause alone, however, does not seem to be sufficient to cause the disease. The knots appear only on vines growing in moist places, and especially in sandy soil in the hotter regions.

Anything which causes a vine to grow vigorously late in the season and prevents the proper ripening of the wood, renders it susceptible to the disease.

In accordance with these ideas, the remedies advocated aim at causing the vine to ripen its wood early and completely. These remedies are drainage of the soil, fertilization with phosphatic manures, longer pruning, raising the trunk of the vine, and removal of the knots.

Swabbing with lime, sulfate of iron, and other antiseptics has proven useless.

Coulure of Muscats.—The Muscat of Alexandria, from which the bulk of our raisins is made, has a tendency to drop its blossoms without setting. This trouble is usually known in California by the French term of "coulure," which may be translated "dropping." The first crop is particularly subject to this defect, which is often so serious that a large part and sometimes the whole of the first crop is lost.

The trouble has been investigated during the last twenty-five years by a large number of observers, and various causes assigned. Among these causes may be mentioned unfavorable weather, improper pruning, fungous attacks, unsuitable or exhausted soil. These causes and others may intensify the trouble, but the primary and essential cause has lately been demonstrated by P. Viala and P. Pacottet, and published in the "Revue de Viticulture."[1]

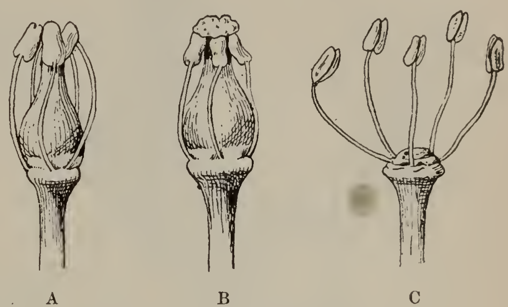

Fig. 19. (After Viala and Pacottet.)

A. Normal flower of the vine, with filaments as long as the pistil.
B. Defective flower of the vine, with filaments shorter than the pistil.
C. Defective flower of the vine, with abortive pistil.

According to these investigations the cause of the dropping lies in the peculiar structure of the flower itself.

The flowers of most cultivated varieties of grapes are what the botanist calls "perfect." That is, each flower has the two elements which are necessary for the development of the perfect fruit. These elements are the pollen contained in the anthers and the ovules contained in the pistil. Unless the ovules are fertilized by normal pollen the pistil will not develop into a normal grape berry.

There are several defects in the Muscat flower which make this necessary pollination more uncertain than with most varieties, and it is only under the most favorable conditions that the ovules are properly fertilized.

In the first place, owing to the shortness of the filaments supporting the anthers, the position of the pollen is such that it may all fall off without reaching the stigma, which is a part of the pistil through which the pollen tube obtains access to the ovule.

In the second place, the pollen is not powdery as with most vines, but waxy and with a tendency to cohere in masses. This renders its

[1] "Sur. la Fécondation Artificielle de la Vigne," Revue de Viticulture, T. XXII, No. 551, pp. 5-10. Paris, 1904.

distribution by wind and insects much less certain. The pollen grains are, moreover, often imperfect, and most of them are incapable of germination and performing their function, even if they reach the stigma.

This is shown when we place the pollen grains in a weak sugar solution. Normal pollen germinates readily in such a solution, but that of Muscat of Alexandria germinates irregularly, imperfectly, or not at all. The same result occurs if the pollen is placed on the stigma of any variety of vine.

FIG. 20. Four-year old Muscat of proper form.

Remedies. — In regions where this variety has been grown for centuries (Asia Minor, northern Africa, Spain) it is usual to plant other varieties having abundant and strong pollen among the Muscat vines. This practice, while not removing the trouble completely, may be of use in California. It would be well in planting a Muscat vineyard to make use of some of the varieties which have shown their ability to produce abundant and vigorous pollen. The proof of this is regular setting of abundant crops. The pollinating varieties might be planted in neighboring blocks, or, better still, in occasional rows.

It is necessary not only that the pollinating varieties should have good pollen, but that they should blossom at the same time as the

Muscat. In accordance with the advice of Viala and Pacottet, the pollen of Aramon × Rupestris has been used with success in the hothouses of Paris for the artificial fecundation of Muscat flowers. This is a resistant stock which produces an abundance of blossoms which are completely staminate, and therefore incapable of producing fruit themselves. Their pollen, however, is extremely vigorous, and causes the fruit of other varieties to set well. The pollen of this variety is collected, dried, and, at the proper time, dusted on to the Muscat blossoms. As this variety blossoms about two weeks earlier than the

FIG. 21. Six-year-old Muscat of usual form.

Muscat, however, it could not be used for cross-pollination unless the pollen were collected and applied as described, which is of course impracticable in a vineyard.

Most of the varieties cultivated in the raisin districts blossom about the same time as the Muscat, and such varieties as Palomino, Perruno, Beba, and Burger, which always set their fruit well, would be suitable for the purpose.

Another peculiarity of the Muscat of Alexandria, noted by Viala and Pacottet, is that the stigma of the pistil is covered with a drop of liquid which forms and falls two or three times a day, thus removing pollen grains which may have reached the stigma. A moist atmosphere is, therefore, unfavorable to the setting of Muscat.

We can control the moisture conditions to some extent by avoiding cultivation or irrigation during and just before blossoming.

The air near the ground is moister than that a little higher up, and the practice of pruning Muscats to a low, prostrate stump is unfavorable for this and for other reasons.

A Muscat vine, like any other, should have a distinct stem or trunk. This trunk should be smooth and without spurs or scars. This trunk

Fig. 22. Low Muscat raised by pruning.

makes it possible to plow, cultivate, and hoe close to the vine without injuring the arms and spurs. It facilitates the removal of suckers from below the ground, and holds the bearing wood high enough up to keep the grapes from touching the ground. How high this trunk should be depends on various conditions. A smooth stem twelve inches in length from the surface of the ground to the branching of the arms is sufficient to give the advantage mentioned.

IMPROVED METHODS OF WINE-MAKING.

BY F. T. BIOLETTI.

The main work in enology has been directed to demonstrating and popularizing certain principles and methods of wine-making, which have been shown to be useful by the experiments of the California Experiment Station.

Cool Fermentation.—The greatly needed reform of the control of temperature in fermentation, which has been advocated by the station for many years, has at last been taken up extensively by the wine-makers of the State. It is no exaggeration to say that the general adoption of methods of insuring cool fermentation will result in doubling the value of our dry wines. Nothing deters the sale and expansion of the market for our fine wines so much as the production of bad wines in our hotter districts. Such wines spoil the reputation of all our wines. If all the dry wines made in California, even in the hottest and most unfavorable districts, were good, sound and wholesome, the market for the finer and higher priced wines grown on the slopes of the coast ranges would quickly expand.

No one change in our methods can have so much influence in this direction as the control of temperature of fermentation. The wines even of our most favorable regions can be improved by the same means.

The actual method of control, providing it is effective, is simply a question of economy. The first attempts of the wine-makers were by means which were both troublesome and inefficient. Efficient methods have been pointed out and demonstrated by the station. The most economical methods will soon be found by the wine-makers, now that they are convinced of the utility of the change.

Heat Extraction.—The new method of wine-making, described in Bulletin 177, has been given a fair trial and the results on the whole have been satisfactory. It has been demonstrated that a good, wholesome wine of remarkable keeping qualities can be made by this means. The color is deeper and more stable than that of wines made in the usual way and the control of temperature is much facilitated. In general, it gives greater certainty of obtaining a good and absolutely sound wine than the older methods. Whether the quality of the wine is equal to that of the best wine made by the older methods is still in doubt. It should be remembered, however, that this method is still new and imperfectly understood. Further tests are needed to demonstrate whether it is capable of producing wines of the highest quality.

The method has been taken up in practice in a limited way, and so far has given satisfaction.

The wines made in this way have shown a tendency to acquire a "port" taste, which is undesirable in dry wine. This taste, however, may be due to the character of the grapes used more than to the method. None of the red grapes grown in quantity in the San Joaquin Valley are suitable for the production of dry red wine in that region. Any grape which, like the Zinfandel, dries up into raisins on the vine, or easily acquires a "rancio" taste, like Mission or Grenache, is unsuited for the making of dry wine in a hot district.

Varieties for Dry Red Wine in the Interior Valleys.—Before the best results possible in the district are obtained, such grapes as Valdepeñas, Lagrain, St. Macaire, Gros Mansenc, Barbera, and Pagodebito, which have proved to retain their color, acidity and quality in the district, will have to be grown. All these varieties have given good results, both in quality and quantity, for years at the Tulare Experiment Station.

Pure Yeast.—Experiments with pure yeasts have been carried out by the station for many years. It is only within the last three years, however, that tests on a large scale have been undertaken. These tests abundantly demonstrate their utility in the hands of efficient winemakers.

They are particularly advantageous in the case of white wines. When used in connection with the preliminary defecation[1] of the must, remarkable improvements have been noted in the quality. If they had no other good effect, the completeness of the fermentation during the vintage, and the rapidity with which the wines become bright, bottle ripe and ready for consumption, are sufficient to justify their use.

Many yeasts have been tested by the station, but the best results, both for red and white wine, have been obtained by the use of one originating in Champagne.

This yeast is strong enough to ferment wines perfectly dry with over 15% of alcohol. It can withstand as high temperatures and as large an amount of sulfurous acid as any of our native yeasts which have been tested. One of its principal advantages is its tendency to form a concrete sediment, which remains at the bottom of the fermenting must or wine, and very much facilitates the racking and clearing. It has also been found equally suitable for champagne and cider-making.

[1] See Circular 22.

Several wine-makers have used this yeast in their wineries, and it has given general satisfaction.

An idea of the benefits to be obtained by the use of a suitable pure yeast is given by a series of tests of the organisms existing on the grapes at the Tulare Experiment Station.

A large number of varieties of grapes were obtained at two different times from Tulare, and an investigation of the organisms existing on them and capable of growing in grape must was made. Although a large number of yeast and yeast-like organisms were isolated, not a single specimen of *Saccharomyces ellipsoideus,* the true wine yeast, was found. Many of the yeasts and pseudo-yeasts were tested by Mr. Hans C. Holm of the station, and all were found in various degrees useless or detrimental to the wine.

As there are no wineries in the vicinity of the Tulare Experiment Station, this is of course an extreme case. In all grapes examined, however, from all sources, the true wine yeast was always found in a very small minority, and accompanied by other organisms which, if allowed to develop, would undoubtedly affect the wine unfavorably.

The best way of avoiding these unfavorable effects is by the use of a starter of pure yeast, preceded, in the case of white wine, with a thorough defecation of the must.

If this measure is properly carried out and accompanied by methods of manipulation which will ensure a pure and thorough fermentation, no trouble will be experienced with "stuck tanks," high volatile acid, "mousey tastes," permanently cloudy wines, or any of the numerous troublesome and costly defects which afflict so many of our wines made in the old, haphazard way.

The utility of pure yeast in our Californian wineries may be considered as demonstrated, but too much must not be expected of it. It will not prevent the ill effects of careless or ignorant practice, and no wine-maker who can not make good wine without pure yeast will succeed with it. For the careful and intelligent wine-maker, it will be a great aid in the improvement of his wines, and in the added certainty of good results. To the careless or unskillful, it may even be a source of danger by accelerating his fermentations and thus increasing the temperature.

Those who wish to test pure yeast are advised to commence with a certified culture from the station, to follow the directions of Circular 23 carefully, and to commence at first only with white wine. With white wine the good effects of pure yeast are more striking, and the possibility of too strongly accelerating the fermentation less to be feared.

COLOR GRAPES.

In many parts of the State the amount of color in the grapes is insufficient for the quantity of red wine which it is desired to make.

The station has, therefore, given considerable attention to the testing of the color capabilities of various varieties in different sections, and to the devising of methods of utilizing economically the color which exists in the grapes now grown.

A variety which has abundant color in one locality may have almost none in another. Carignane, Grenache, Mourastel, Aramon, which usually contain sufficient color in the coast counties, can be used only for white wine in the hotter parts of the central valleys unless blended with color grapes.

The color of all varieties is less in quantity and less stable in character in the warmer climates and richer soils. A careful choice of varieties in this respect is, therefore, necessary in the central valleys. The following table, compiled from a large number of tests, illustrates this point:

Colors of Grapes in Cool and in Hot Localities.

Variety.	Cool Localities.		Hot Localities.	
	At Pressing.	At 4 to 6 Months.	At Pressing.	At 4 to 6 Months.
St. Macaire	2 1VR 189	2VR 66	VR 138	2VR 30
Gros Mansenc	6 2VR 119	3VR 61	3VR 64	4VR 24
Gamai Teinturier	7 2VR 96	3VR 38	5VR 36	5VR 11
Barbera	9 1VR 88	3VR 28	1VR 69	5VR 20
Refosco	8 1VR 93	4VR 29	1VR 54	5VR 17
Petite Sirah	4 VR 133	3VR 48	3VR 44	Y 13
Petit Bouschet	1 VR 239	1VR 74	3VR 49	2R 15
Alicante Bouschet	3 1VR 151	1VR 53	4VR 40	4R 13
Valdepeñas	5 1VR 129		1VR 35	2R 12
Pagodebito			VR 49	
Alicante Ganzin	VR 667			
Lagrain			1VR 63	

This indicates that for the San Joaquin Valley the best grapes for color, of those commonly grown in the State, are St. Macaire, Gros Mansenc, and Barbera, in the order named. Wines made from these varieties at Tulare and Fresno have from half again as much to three times as much color as the Bouschets, and the tint is better and more stable. In aging, the other varieties, such as the Bouschet and Sirah, retain barely enough color for a standard wine, and the tint becomes very yellow. None but the three varieties mentioned, together with the Refosco, have always kept enough to allow them to be mixed with varieties lacking in color.

Besides color, these three varieties retain high acidity and a freshness which make them very valuable in this district for dry red wine.

The color of a wine depends not only on the character of the grape from which it is made, but also on the process of manufacture. The utility of sulfur fumes and sulfites in dissolving and keeping the color has already been pointed out in Bulletin 177. It has also been shown in the same publication that the heat-extraction method also results in deeper and better color than the ordinary method of fermentation. This is exemplified further by some tests made on grapes grown at the Tulare Experiment Station.

These grapes were received on September 17, 1907, and each variety divided into two equal lots. One was fermented in the ordinary way, and the other was heated to 65°C. for three hours, and the juice after pressing out fermented without the skins. The results are shown in the following table:

Extraction of Color by Heat and by Fermentation.

Variety.	Composition.		Heated Must.		Fermented on Skins.
	Solid Contents.	Acid.	Before Fermentation.	After Fermentation.	
Lagrain	25.0	.60	VR 190	2VR 89	1VR 63
Pagodebito	22.0	.67	VR 148	1VR 74	VR 49
St. Macaire	25.0	.83	VR 148	1VR 52	2VR 41
Alicante Bouschet	20.7	.71	1VR 118	2VR 56	3VR 44
Gros Mansenc	24.0	.83	VR 105	1VR 55	1VR 41
Valdepeñas	23.0	.52	VR 80	VR 33	1VR 26
Beclan	22.0	.45	VR 78	1VR 30	2VR 17
Mean			VR 124	1VR 56	2VR 40

Variety.	Color Remaining at 1 Month.		Color Remaining at 10 Months.	
	Heat Extraction.	Ordinary Fermentation.	Heat Extraction.	Ordinary Fermentation.
Lagrain	2VR 89	2VR 44	4VR 47	R 16
Pagodebito	2VR 63	1VR 36	5VR 38	3R 24
St. Macaire	5VR 48	1VR 43		3VR 20
Alicante Bouschet	3VR 49	1VR 46	4VR 34	4VR 20
Gros Mansenc	3VR 50	1VR 48	3VR 15	3VR 23
Valdepeñas	2VR 37	1VR 24	2VR 27	5VR 16
Beclan	3VR 29	4VR 16	5VR 12	2R 10
Mean	3VR 42	2VR 39	3VR 39	5VR 18

Summary of Results in Table.

		After Fermentation.	After 1 Month.	After 10 Months.
A. Heated must	VR 124			
B. Fermented must		1VR 56	3VR 42	3VR 39
C. Ordinary fermentation		2VR 40	2VR 39	5VR 18

These tests illustrate the beneficial effect of heat extraction on the amount and the permanency of the color. This is shown in table, where A represents the total average amount of color extracted by heat. This may be taken to indicate the total amount of color contained in the grapes. Of this amount 45% remained in the wine immediately after fermentation, while only 32% was extracted by the ordinary process of fermentation.

At the end of ten months the wines made by heat extraction had lost 48% of their color, and those made by the ordinary method, 55%. At ten months, therefore, the wines made by heat extraction had on the average 61% more color than those made by the ordinary method (see B, C in table), and the quality of the color, 3VR, instead of 5VR. was also superior. These results corroborate those reported on page 28 of Bulletin 177, where experiments made on a large scale under the conditions of an ordinary winery showed a gain of 42% at four and one half months in favor of heat extraction. The gain appears to be the greater the older the wine, showing superior stability of the color when extracted by heat.

The need of more color in the wines of many districts has led to the planting of a considerable area of Lenoir vineyards. The Lenoir is an unsatisfactory grape for this purpose, however. The color is unstable and quickly becomes yellowish. The color, even at first, is little if at all deeper than that of several vinifera varieties, and if any considerable proportion of the grapes are used they very much diminish the quality of the wine.

A recently imported grape, the Alicante Ganzin, gives promise of being much superior for this purpose. This vine is the product of a cross between Alicante-Bouschet and Aramon-Rupestris, and is, therefore, three fourths vinifera. Its resistance to Phylloxera is about equal to that of Lenoir, and it can, therefore, be safely planted without grafting only in the rich, deep soils where Lenoir resists.

The wine is better than that of Lenoir and almost without foxy or other undesirable flavor. Its value consists in the great intensity of its color. A sample of the grapes grown by Mr. F. T. Swett of Martinez was received at the laboratory and tested for color, with the following results:

Color of Alicante Ganzin.

A.	Heated to 90°; color of must	VR — 800
	A, after fermentation, color of wine	VR — 667
B.	Fermented on skins; color of wine	VR — 667

The color is thus shown to be of the best tint, and more than twenty times as intense as a good Zinfandel, or twice as intense as the darkest Bouschet.

In order to test the color remaining in the pressed pomace it was mixed with white must, and fermented, with the following results:

C. 1 part pomace from A + 4 parts white must + .4% citric acid.
Color of wine ....2VR — 66

D. 1 part pomace from B + 4 parts white must + .4% citric acid.
Color of wine ....2VR — 67

This shows that all the color remaining in the pressed pomace can be extracted and utilized by refermenting with white of lightly colored grapes. The wines after fermentation were kept in bottles, and three weeks later showed the following amounts of color:

A.	VR 441	loss 33%
B.	VR 364	loss 45%
C.	2VR 56	loss 15%
D.	2VR 57	loss 15%

This indicates the superior stability of the color extracted by heat (A) over that extracted by the usual method of fermentation (B). It also shows that blending should be done as soon as possible, preferably in the fermenting vat, in order to preserve as much as possible of the color.

The color of this wine when undiluted is so deep that it can be used for writing. It may be useful for coloring jellies in place of the various coloring matters often used. One ton of Alicante Ganzin fermented with twenty-five tons of white grapes would give a red wine of standard intensity of color. If fermented with red grapes, which were too light, but still had some color, one ton would be sufficient to bring fifty to seventy-five tons up to the standard.

GRAPES FOR DRY WINE IN THE SAN JOAQUIN VALLEY.

In a general way it may be said that the varieties, red more especially, which have given good results in the coast regions fail to produce good dry wines in the hot interior. They are usually deficient in acidity and color, many produce wines of flat and insipid character, and a large number acquire a "port" taste which is undesirable in dry wine. Certain varieties which yield a fair dry wine in the cooler regions can be used successfully for port in the hotter. Examples of this are Zinfandel, Alicante Bouschet, Charbono, and Carignane. Varieties such as Grenache, Mataro, Mission, Trousseau, Chauché Noir, and California Black Malvoisie do not produce a good dry wine anywhere. This includes practically all the red wine grapes which are grown to any considerable extent in the San Joaquin and Sacramento valleys. In the central and cooler parts of this region the Zinfandel, Carignane, and Alicante Bouschet give good crops of passable quality. In the hotter parts their wine is very defective.

Nearly all of these varieties, however, could be used successfully if they could be blended in the fermenting vat, or soon after, with 25% to 50% of other varieties, which have the characteristic which they lack.

The main defects of the wine of the varieties at present grown in the interior are low acidity, insufficient and unstable color, a tendency to oxidation (rancio taste), and a lack of that indefinable quality known as "freshness." The Zinfandel, especially the second crop, when picked in prime condition, is perhaps the best of all the varieties at present grown in the interior. It is, however, too subject to drying up and black mold to be relied upon as a dry wine grape. The peculiar flavor of the Zinfandel, moreover, becomes too intense in the hotter regions.

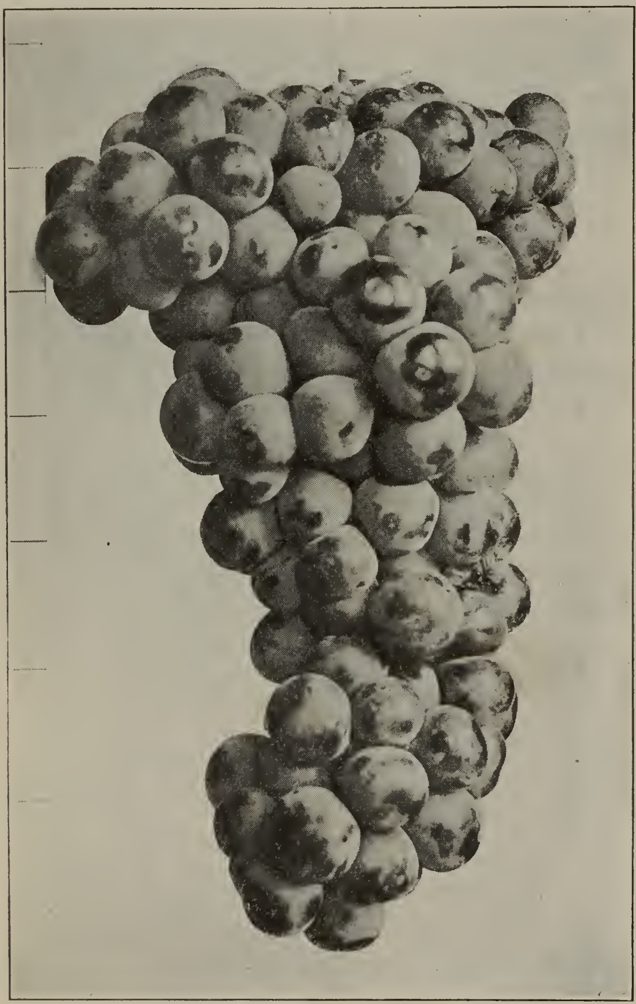

FIG. 23. Valdepeñas. Five eighths real diameter. Bunch one fourth natural size.

Of all the varieties which the station has tested in the interior valleys, that which combines the largest number of good points as a dry wine grape is the Valdepeñas. This variety, originating in Spain, is unsatisfactory in cool regions. In Napa and Sonoma its bearing is insufficient, and the wine is harsh and without high quality. These qualities, even there, are modified and improved by grafting on resistant stock, especially on Riparia, and in the hotter parts of the interior they disappear completely.

The Valdepeñas at Tulare has produced regularly large crops of fine, clean grapes with short pruning. It is not subject to sunburn or black mold, and the grapes will stay on the vines, without injury, as long as those of any variety. The wine made from it has always been satisfactory, showing color, acidity, and freshness almost equal to wines made in the coast counties. If only one variety were to be planted for dry red wine in the upper San Joaquin Valley, this undoubtedly would be the best of any that have been tried.

What is needed, however, perhaps more than a variety which will make a good wine itself in this district, is one which by blending can be used to correct the deficiencies and defects of the varieties already growing there. Varieties which will bear good crops of grapes with full acid and color would be of great service to the wine-makers of the interior, and enable them to bring up the quality to the Zinfandel, Carignane, and Bouschet sufficiently to make a good, sound, bulk, dry wine.

The experience at the Tulare Experiment Station, where a large number of varieties have been grown for twenty years, enables us to recommend certain good bearing varieties for this purpose. Those which have given the best results are:

Valdepeñas	quality
Lagrain	color and quality
St. Macaire	color and acidity
Gros Mansenc	color and acidity
Barbera	color and acidity
Pagadebito	color and acidity

Varieties for Dry White Wine in the Interior Valleys.—Dry white wines of fair quality can be made in the hot interior districts more easily than red. They have some of the same defects as the red, viz., lack of acidity, flavor, and freshness. By proper choice of varieties, and careful methods of manufacture, however, marketable white wines can be made with some of the varieties now growing there.

The Burger is peculiarly suited to these regions. It yields a neutral, clean tasting wine, which only requires blending with a full flavored wine from the coast regions to be worthy of aging and bottling. This was abundantly demonstrated by the experiments detailed in Bulletin 177. Burger wine, made in experiment VIII, developed into a surprisingly clean tasting, agreeable wine. The Burger retains its acidity better than most varieties at Tulare, but still requires blending with coast-county wines or the addition of citric acid. The white varieties which have developed the highest acidity have been West's White Prolific and Vernaccia Sarda.

The Johannisberger and Franken Riesling have given unexpectedly good results in the San Joaquin Valley. The wines of experiments

VI and VIa of Bulletin 177 have developed into wines showing flavor and bouquet that almost entitle them to be classed as fine wines. They have, however, a certain heaviness that should be corrected by judicious blending.

That the Rieslings, which produce the finest wines of the Rhine, should succeed under the totally different conditions of the San Joaquin Valley, shows that the origin of a variety is not always a safe guide as to its adaptability. The Sercial, from which the fine dry wines of the Island of Madeira are made, is said to be identical with the White Riesling used in the manufacture of the famous wines of Schloss Johannisberg.

A STUDY OF YEASTS FROM CALIFORNIA GRAPES.[1]

BY HANS C. HOLM.

The varieties of Saccharomycetes and Pseudo-yeasts, described in the following pages, were obtained originally from California grapes, of which some were sent from the Experiment Station at Tulare, and others were purchased at the local market in Berkeley.

The line of experiments was carried out with the intention of determining the amount of alcohol which the various yeasts were able to form in a sugar solution, and whether the yeasts on California grapes mainly consisted of types which might be depended on in wine-making. The fermentations were not restricted to must alone, but artificial media were made up in order to study the action of the yeasts on various sugars, that is, on dextrose and on saccharose. The so-called Laurent solution (see below) was used, and the specific sugar added. Comparative tests of fermentation carried out in grape-must, saccharose and dextrose solutions were made, and the results will be found below (see table).

The yeasts were all used in pure cultures only; the pure cultures were made by Koch's plate-culture methods, and in all cases not less than two sequent series of plate-cultures were made in order to eliminate the chance of impurity—that is, the presence of more than one species in the culture—to the least possible figure. The gelatine used in these experiments was a gelatine made up of must (10% Balling), 14% gelatine and .05% phosphate of potassium. It was found that a percentage of gelatine less than 14% would be impracticable, as the gelatine hardens with difficulty in the hot summers of California, and a liquefaction of gelatine in the plate-cultures would of course make the experiment uncertain, if not entirely unreliable:

Laurent's Solution.

Ammonium sulphate	4.71 grms. per liter
Potassium phosphate	0.75 grms. per liter
Magnesium sulphate	0.10 grms. per liter

To this solution any sugar may be added in the desired quantity.

The yeasts examined have been numbered for the sake of reference, and pure cultures of these varieties are left in the pure-yeast collection belonging to the Department of Viticulture, University of California.

[1] Written as a Thesis for the degree of B.S.

It was the experimenter's idea that the amount of carbonic acid gas formed during fermentation might give some comparative results if collected in fermentation tubes, and that in this way it might be possible to eliminate all those yeasts which do not ferment sugar at all, and also to classify the varieties of yeasts as "high" and "low" fermenting yeasts. The result was a rather negative one, it being found that most of the varieties were strictly obligate-aërobic, and that they under no conditions could be brought to form any carbonic acid gas (or other gas) in the closed end of the fermentation tube. The further details of these experiments are stated on the following pages.

SACCHAROMYCES ELLIPSOIDEUS BIOLETTI I.

(This variety has been named after Assistant Professor F. T. Bioletti, Department of Viticulture, University of California.)

The yeast was isolated from grapes purchased on the local market in Berkeley. The form of the yeast as seen under the microscope is elliptical.

A 10% water solution of cane sugar in a fermentation tube was inoculated and placed in the incubator at 25°C. After four days the solution was examined. Neither film formation nor gas was noticed. In order to determine whether this inactivity was due to lack of nutritive contents a parallel experiment was carried out, with a Laurent solution containing 1% of cane sugar. After being placed for four days in the incubator at temperatures between 22°C. and 25°C. the result may be stated as follows: No growth, no gas, no film, and but a slight turbidity, indicating the growth of the yeast, but apparently without gas formation.

A fermentation tube containing 10% must was next inoculated with Sacch. Ellip. B. I, and placed in the incubator at 25°C. After twenty-four hours no gas or turbidity was noticed, but on the following day gas formation began, and gradually a large amount was formed in the closed tube. The gas was tested with a 5% KOH solution, and found to be carbonic acid. The gas formation now became so rapid that it was evident that a 10% must was much too concentrated, and for matter of comparison with results from other yeasts would have to be replaced by a 1% solution. However, the experiment with the use of fermentation tubes was not carried any further on this yeast, because the experiments on the other varieties showed the fermentation tubes to be unsuited to comparative tests.

A series of experiments was now carried out on Sacch. Ellip. B. I, as well as on all the other yeasts isolated from Californian grapes. Ordinary must, as well as Laurent's solutions, were inoculated with the various yeasts, and the alcohol formed was determined by distillation.

The specific gravity was taken by means of a picnometer, and Windish's tables (Berlin, 1893) were referred to. For the determination of extract the specific gravity was taken, and the corresponding per cent of extract was found from the tables.

A must containing 21.67% Balling was inoculated with Sacch. Ellip. B. I, and the fermentation was carried through at an average temperature of 24°C. The yeast settled well, and the liquid remained clear without any film formation, and a high aroma was noticed. After eighteen days the fermentation was at a standstill, and an analysis showed the amount of alcohol to be 10.61%, leaving 2.69% of extract in the fermented liquid.

The same yeast was next inoculated in a Laurent solution to which saccharose had been added until the solution showed a 19.68% Balling. After the fermentation had ceased, that is, after eighteen days at a temperature of about 25°C., the alcohol was found to be 2.09% by volume, leaving 12.19% Balling in the liquid after fermentation. The yeast had settled well and no film formation was noticed.

A Laurent solution made up with the addition of dextrose was next inoculated, and after eighteen days at 23°C. the alcohol was found to be 3.49 by volume. The extract in the dealcoholized must was found to be 5.87% Balling. The yeast had settled well, leaving the liquid bright, and a high aroma was noticed.

These results show that the yeast has a very slight inverting power, because the cane sugar remained practically unfermented. The results also tend to show that the Laurent solution is a rather unsatisfactory medium, as far as yeast is concerned; and the results derived from fermentations with other yeasts only verify this conclusion. The importance of the chemical composition of the medium is clearly illustrated in the results from the three experiments, carried out respectively with must, cane sugar solution, and dextrose solution, the two latter sugars being dissolved in Laurent solution. The yeast grows best in its natural medium, and the application of an artificial solution, as that of Laurent, can only be recommended in special cases where the activity of the yeast on a specific kind of sugar is to be determined. It is here of special importance that the liquid does not contain even traces of acid, as an acid solution would gradually of itself act on the sugar and change the saccharose into invert-sugar.

YEAST 26. FROM BURGER GRAPES.

This yeast was obtained from "Burger" grapes from Tulare. The crushed grapes were placed in the incubator for four days at a temperature of 30°C. Dilution cultures were made, and the plates showed besides the omnipresent *Apiculatus* yeast, another yeast resembling a

Mycoderma in shape and size. A pure culture was made of this variety, and named "yeast 26." Experiments were carried out with the pure yeast, and the results are as stated in the following:

With Fermentation Tubes: (*a*) A 12% grape-must was inoculated. A gray film formed on the surface, and a large amount of gas collected in the closed tube. The film formed by this yeast differs greatly from the film formed by another variety of yeast described later, namely, yeast 28.

(*b*) Inoculation in a 10% cane-sugar solution: No gas was formed, but after four days a light gray film was formed on the surface and the solution showed a slight turbidity.

(*c*) Inoculation in a Laurent solution containing 1% saccharose: The growth of the yeast was most vigorous, but no gas was produced after an incubation period of nine days. A gray film was formed and the liquid became turbid. The fermentation was carried out at a temperature of 23°C. The microscopical appearance of the yeast was that of an elliptical yeast rather than that of a *Mycoderma;* but it may be stated that this experiment, as well as all the rest in this series of investigations, clearly showed that the general form of the yeast cells was not to be considered a constant, but a variable quantity, which might be said to be a function of the specific medium in which the yeast was grown. This yeast forms, when grown on must-gelatine, cells resembling the cells of a *Mycoderma* form.

(*d*) A fermentation tube containing a must showing 10% Balling was inoculated with the pure yeast. A small amount of gas collected in the closed tube, the liquid became turbid, and a gray film was formed.

For the Determination of Alcohol: (*a*) A must containing 21.67% Balling was inoculated and placed for eighteen days in incubator at a temperature of 23°C. The alcohol was determined by distillation and found to be 3.78% by volume; 12.12% extract was left in the must after fermentation.

(*b*) Laurent's solution containing about 19.68% saccharose was inoculated, and after eighteen days examined. The content of alcohol was found to be 1.14% by volume, leaving 12.71% extract unfermented.

(*c*) A Laurent's solution, with addition of dextrose, was next inoculated. The strength of the solution was 12.84% Balling. Alcohol formed after eighteen days of fermentation was 5.10% by volume, leaving 1.76% extract unfermented.

This yeast formed more alcohol in the artificial dextrose solution than in the must. It has a slight inverting power, and seems to grow in saccharose solution without forming alcohol in considerable quantity.

The yeast is not strictly obligate-aërobic, but rather facultative-anaërobic.

YEAST 28. .FROM ZINFANDEL GRAPES.

This is a pure culture of a variety of yeast found on Zinfandel from Tulare Experiment Station.

With Fermentation Tubes: (*a*) Inoculation in a 10% grape-must. After five days at 23°C. no gas appeared; liquid became turbid and a film was formed, differing in appearance from that of yeast 26.

(*b*) In Laurent's solution containing 1% saccharose the yeast produced a gray film, a strong growth, and turbidity; the macroscopical appearance was in every respect similar to that of yeast 26, but the miscroscopical examination showed very long sausage-formed cells, recalling a Pastorianus form.

For the Determination of Alcohol: (*a*) Inoculation in must of 21.67% Balling gave 5.03% alcohol by volume, leaving about 9.00% extract in unfermented form.

(*b*) Fermentation in a Laurent's solution with the addition of saccharose gave, after eighteen days at 23°C., 2.09% alcohol, producing an attenuation from 19.68% Balling to 11.23% Balling.

(*c*) Fermentation in a Laurent's solution to which dextrose had been added until the solution showed 12.84% Balling gave 4.80% alcohol, after eighteen days of fermentation at a temperature of 23°C. The extract left after fermentation was 2.32%.

YEAST 37. FROM ZINFANDEL GRAPES.

If grown in grape-must this yeast forms a thick gray film on the surface.

With Fermentation Tubes: (*a*) 10% saccharose solution. The yeast formed no gas after four days, no turbidity was noticeable, but a slight film formation.

(*b*) Inoculation in a Laurent's solution containing 1% cane sugar gave the same result as the 10% cane-sugar solution above, but also turbidity. The microscopical appearance was the ellipsoideus form.

(*c*) 10% grape-must. No gas was formed in the closed tube; the liquid became turbid, and a film appeared on the surface.

For the Determination of Alcohol: (*a*) Fermentation of must of 21.67% Balling gave, after eighteen days at 23°C., 1.95 alcohol by volume, leaving 16.57% extract in the liquid.

(*b*) Saccharose dissolved in Laurent's solution, showing 19.68% Balling, was reduced to 14.56% Balling. The alcohol formed was only 0.27%.

(*e*) Dextrose dissolved in Laurent's solution gave only 0.13% alcohol. The strength of the solution was 12.84 at the beginning of the experiment. Evaporation during the fermentation process increased the Balling to 13.84%. This explains the fact that 12.82% was found as the percentage of extract in the dealcoholized must.

From the above results it is seen that this yeast has very little fermentative activity. It maintains its life by feeding upon the solid contents of the must, as well as on the saccharose. However, it has no power of utilizing the dextrose. The yeast practically does not form alcohol.

YEASTS 45A AND 45B. FROM ZINFANDEL GRAPES.

A Laurent's solution containing 1% cane sugar was inoculated, and in both cases no gas formation was noticed in the closed fermentation tubes. Both yeasts produced a slight turbidity.

By inoculation in fermentation tubes containing a 10% must, both varieties formed a slight film, but neither gas nor turbidity was noticeable.

In regard to the fermentation, or rather the production of alcohol in two Laurent's solutions, containing respectively saccharose and dextrose, both varieties of yeasts formed practically no alcohol, but reproduction took place.

Analogous experiments carried on in a must showing about 21% Balling gave a result of 1.6% alcohol for the yeast 45A, while 45B gave an amount of alcohol less than 0.3%.

The tests for alcohol were made twenty-five days after inoculation, and the fermentations had in both cases taken place at 23°C.

These two yeasts belonged to the varieties of yeasts found on grapes. They are useless, as far as wine-making is concerned, being unable to produce alcohol or give any bouquet to the wine. Whether both belong to the same variety is difficult to say; the slight differences noticed in their cultural characteristics would hardly suffice to decide this question. However, yeast 45A seemed by far the more active of the two cultures.

YEASTS 46A AND 46B. FROM BURGER GRAPES.

Both yeasts form, when grown in grape-must, a thick, gray film. (*a*) When grown in a pure 10% cane-sugar solution in fermentation tubes, neither of the two varieties formed any gas in the closed tube, after an incubation period of four days at 25°C., but a gray film was present on the surface of the liquid in both cases.

(*b*) When Laurent's solution containing 1% saccharose was inoculated with the yeasts, they were found to be "no-gas" producers. Strong turbidity resulted in both cases. So far the varieties behaved alike, but a microscopical examination showed a great difference in regard to size and form. Yeast 46B had an elliptical form, while yeast 46A was more elongated, forming long chains of cells, and highly reminding of a Pastorianus form.

(*c*) Both yeasts were also tried in fermentation tubes containing a 10% must, but neither film nor gas was noticed; a slight turbidity resulted in both cases.

Experiments to determine whether these varieties formed any alcohol showed that the amount formed in each case was very small. These results will be found in the table. The most characteristic fact is that these varieties differ also in respect to the amount of alcohol formed. Yeast 46A formed about twice the amount of alcohol obtained from 46B, when grown in must. The percentages of alcohol formed in saccharose and in dextrose solutions were in both cases very small.

		Ellip. B. I.	Yeast 26.	Yeast 28.	Yeast 37.	Yeast 45A.	Yeast 45B.	Yeast 46A.	Yeast 46B.
LAURENT'S SOLUTION WITH SACCHAROSE.									
Must	Specific gravity	1.0758	1.0758	1.0758	1.0758	1.0758	1.7058	1.0758	1.0758
	Balling	19.68	19.68	19.68	19.68	19.68	19.68	19.68	19.68
Wine	Sp. gravity of dist	0.99694	0.9983	0.99694	0.9996	0.9999	0.9997	0.9994	0.9996
	Alcohol by weig't	1.66	0.90	1.66	0.21	0.11	0.16	0.32	0.21
	Alcohol by vol.	2.09	1.14	2.09	0.27	0.13	0.20	0.40	0.27
	Ext. dealc. liq.*	12.19	12.71	11.23	14.56	15.53	15.42	15.50	15.92
	Specific gravity	1.0471	1.0491	1.0434	1.0562	1.0599	1.0595	1.0598	1.0614
LAURENT'S SOLUTION WITH DEXTROSE.									
Must	Specific gravity	1.0496	1.0496	1.0496	1.0496	1.0496	1.0496	1.0496	1.0496
	Balling	12.84	12.84	12.84	12.84	12.84	12.84	12.84	12.84
Wine	Sp. gravity of dist.	0.9949	0.9927	0.9931	0.9999	0.9999	0.9997	0.9995	0.9997
	Alcohol by weig't	2.77	4.07	3.81	0.11	0.11	0.11	0.11	0.11
	Alcohol by vol.	3.49	5.10	4.80	0.13	0.13	0.20	0.33	0.20
	Ext dealc. liq.*	5.87	1.76	2.32	12.82	12.56	12.58	12.30	12.52
	Specific gravity	1.0227	1.0068	1.0090	1.0495	1.0485	1.0486	1.0475	1.0484
GRAPE MUST.									
Must	Specific gravity	1.0834	1.0834	1.0834	1.0834	1.0834	1.0834	1.0834	1.0834
	Balling	21.67	21.67	21.67	21.67	21.67	21.67	21.67	21.67
Wine	Sp. gravity of dist.	0.9859	0.9945	0.9929	0.9971	0.9976	0.9996	0.9974	0.9988
	Alcohol by weig't	8.42	3.00	3.99	1.55	1.28	0.21	1.39	0.64
	Alcohol by vol.	10.61	3.78	0.80	1.95	1.61	0.27	1.75	0.80
	Ext. dealc. liq.*	2.69	12.12	11.78	16.57	18.08	18.97	17.77	17.07
	Specific gravity	1.0104	1.0468	1.0455	1.0639	1.0697	1.0731	1.0685	1.0658

*Ex. dealc. liq.: Extract in dealcoholized liquid.

The series of experiments indicate that most of the yeasts found on our California grapes grown in regions remote from wine-making operations are inactive as regards the formation of alcohol; and many of them are detrimental to the wines, producing film formation and turbidity. Most of these varieties also impart an unpleasant flavor and taste, and their general characteristics do not favor the production of a sound wine of good quality. The remedy for repressing the growth of these organisms is to be found in the general introduction and application of pure yeast in California wineries.